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STABLES WITH HORIZONTAL FLOORS.

THE construction of our stables or stalls for the accommodation of our large domestic animals is not always such as it should be. To prevent the saturation of the flooring and the decomposition of the bedding, it has been the custom for a long time to pave the floor itself and to give to this pavement a certain inclination to accelerate the flow of water. According to this system, the pavements in the stalls often show an inclination of from three to six centimeters per meter, and often even more than this. It is to this fault that must be attributed the malformation of our cattle, the irregularity in the members, the weakness in the joints, the rapid deterioration of the limbs, and the general degradation of the race. The permanent dampness of the bedding affects the soundness of the feet of horses; the ammoniacal gases with which the atmosphere is saturated affects the eyesight and the respiratory organs. Fig. 3 offers a striking example of the sad effects pointed out. This represents a cavalry officer's charger of good breeding, but "over at the knees" and low at the withers, that is to say, deformed, and this, too, brought about by the inclination in the floor of the stable in which he was reared

FIG. 1.—A HORSE IN GOOD CONDITION.

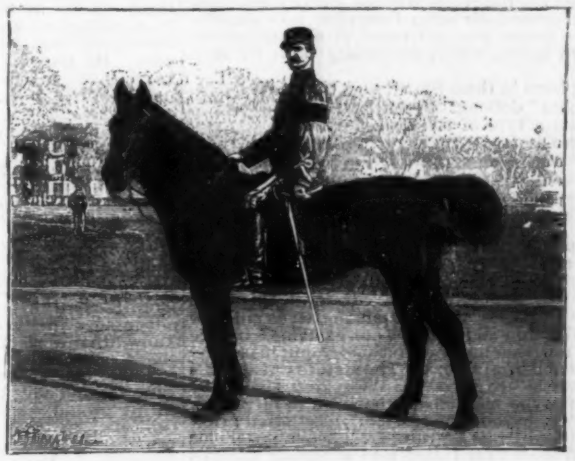


FIG. 3.—BAD EFFECTS OF INCLINED FLOORS.

The problem of how properly to construct the floors of stables and stalls has fortunately been solved by Col. Basserie, a former member of the first committee on steeds. This system consists in an apparatus for drainage made of cast kennel stone, and sunk in the floor in a cement which is impervious to liquid. The drain is formed by being sunk under the surface, and having sides of kennel stone and a cast cover or lid. This cover has a slight longitudinal concavity smaller than the size of the shoe of the smallest horse and having, furthermore, a series of apertures at the lowest point, made as small as possible, to enable the free flow of the water, and still made of such a size as not to catch or retain in any possible way the heel of the shoe. This type of strainer enables the liquid to flow into the drain, which can be readily cleaned, as the cover being hinged is readily removable. The separate drains of each stall connect with a main drain which passes along the end of the stalls, and this connects with a receiving cistern. Such briefly is the type of the stable Basserie.

The advantages are very evident. Fig. 3, we have seen, shows an animal badly put up. Fig. 1 represents the same officer on another horse, which, although no better bred than the other, still shows much better traits, in that he was put on a horizontal floor before his growth was completed. The difference between the two types is very striking.

Already applied in over forty departments in France, the Basserie system is very highly thought of. Fig. 2 represents the interior of a stable having a horizontal floor and hygienic drainage, built according to this system, at Mans, for the section general of the fourth corps of the army. A similar system should be adopted in all our cavalry stables.—*L'Illustration.*

FIG. 2.—INTERIOR OF STABLE WITH HORIZONTAL FLOORS AND HYGIENIC DRAINAGE.

A PROPOSED GOVERNMENT BREEDING FARM FOR CAVALRY HORSES.

By Lieut. S. C. ROBERTSON, U.S.A., First Cavalry.

THE breeding of horses in the United States has of late years confined itself largely to the production of three classes—trotters, thoroughbreds, and draught horses; and the type of animal fit for ordinary saddle purposes, and from which should come our cavalry mounts, is being correspondingly neglected. There are in Tennessee and Kentucky, and certain Northern and Northwestern States, it is true, special breeders of saddle horses, most of which are serviceable for cavalry use. But the cost of breeding these animals, owing to the large proportion of thoroughbred blood they contain, and, it may be said, the limited scale on which they are raised, renders them unavailable for our remounts.

This predilection in favor of special breeding has extended itself not only throughout most of the stock regions in the East, but also to the extreme States and Territories of the frontier. Western ranchmen in Dakota, Montana, Idaho, Oregon, Washington, California and (though we believe to a less extent) in the more Southern Territories, are now freely serving their American, half bred, and "Cayuse" stock with Clydesdale and Percheron stallions.

Bands of horses in these regions that a few years ago contained many good half-bred American animals, and which formed the reservoirs whence cavalry purchase boards then drew their annual supplies, now show in their stead a larger preponderance of clumsy, coarse-limbed work horses, which are totally unfit for such service.

In many places in these States and Territories, with "horse ranches" dotting the country in all directions, it is rare that a type of the clean limbed, stylish, *real* cavalry horse is found. The writer knows from personal experience that purchase boards in Idaho, Oregon and Washington Territories are now almost wholly unable to get anything in the way of mounts equivalent to the liberal prices offered. The officers composing them, after distributing circulars far and wide in the neighborhood of their posts, or along the route over which they are to travel, will sometimes remain in session for many months in order to fill the annual deficiencies in a half dozen troops of cavalry. The sums allowed for purchase are large ones (often as much as $150 and $175), and many horses are examined by the boards, yet few thoroughly satisfactory purchases result from their season's work. The majority of animals presented are either base-bred "Cayuse" stock, the logy draught type mentioned above, or, in rare cases, blooded horses, beyond the reach of the allotted price. Finally, the board gets a "rap" from headquarters for delay, and is often thus forced into accepting animals which its own judgment forcibly disapproves.

The average cost per head of the artillery and cavalry horses throughout the different departments was for the last two fiscal years about $143. The records of the quartermaster-general's office will show how many of these horses are condemned soon after purchase and sold at one-third or one-fourth of their original cost to the government. In several cases, which I have in mind, some of these purchases have died from exhaustion upon short marches within in a month or so after being received into their troops. The trials of purchase boards in the respect just mentioned are not solely limited to those regions where horse breeders are rare. The writer was not long since on a board in such a country as Southern Oregon, for instance—one famous in the West for its horses—and can testify to the board's inability, after months of labor, to get something less than a dozen ordinary cavalry mounts. The price allowed per head was $125, which should be amply sufficient for such animals as were needed, in a country well stocked with horses. The same complaints on this subject come from other departments of the army. The testimony of many competent officers is that our system of supply is a faulty one, and a glance at the ranks of many of our troops certainly could corroborate it. Where is the defect and what the remedy?

I believe that those officers whose judgment on such points is best, and whose experience is far larger than my own, will agree that the defect lies mainly in the following facts:

1st. That special breeding in other directions is rendering it more and more difficult, each year, to obtain the proper type of cavalry mount.

2d. That the absence of depots in accessible places, to which raisers could bring their animals for sale, and the desultory manner in which purchase boards are compelled to travel through the country in search of material, is not a system best calculated to obtain such animals as *are* fit for the service.

3d. That the fluctuating nature of prices, depending upon the amount of the yearly appropriations, is not calculated to encourage the raiser to seek the government market. A dealer who is offered only $125 for an animal for which another board, more liberally supplied with funds, would have the year before given $150, is naturally disgusted and inclined to seek a more equable mart for his wares.

4th. That officers are rarely put upon purchase boards with regard to special fitness therefor, and that the changeable character of the yearly boards allow few to ever become experts. In European cavalry the "remount officer" is selected from those specially trained in hippology, and fitted by their knowledge of the horse and of the tricks of dealers to competently purchase him. The services of such men are highly valued, and they are continuously kept in demand. By this means their knowledge of the market and their relations with the different dealers remain unbroken from year to year, with obvious advantage to the government.

Now, the remedy for these defects would seem to lie in one of two alternatives.

I. PURCHASE SYSTEM.

The first is one suggested by Capt. Geo. E. Pond, Quartermaster's Dept., and A. Q. M. to and member of the Purchase Board for the Division of the Missouri in 1884. He points out in a letter to the Q. M. General, which the latter publishes in his annual report for 1884, several of the faults mentioned above, laying especial stress upon the first two. To obviate these, he proposes the establishment at Leavenworth "of a general horse depot, on the same plan of general depots of the quartermaster's department, for supplying the whole service with all animals for cavalry, artillery or draught purposes. This depot to be directly under the quartermaster-general, and to have in stable a sufficient number of animals to meet the ordinary demands of the service, say 250 or 300. Then, as animals are wanted they could be supplied on approved requisitions, the same as other stores, and the reserve filled up by purchase (in open market or by contract). The government owns a large and valuable reservation at this place, most admirably adapted for this purpose. A comparatively small outlay (say $15,000) would build the necessary stables, etc.; a large part of the year the animals could graze. By careful management, with aid from the labor of military convicts, the necessary hay could be cut, and even the forage be raised for the use of the depot on lands owned by the government.

"The officer in charge should have authority to purchase animals when needed, and could take advantage of the market, if the present system is retained, and in a short time farmers and raisers would bring their stock direct to him, and being under no immediate necessity, he could select only the best. Animals could here receive a preliminary training, be thoroughly broken to the saddle, and besides be properly shod, so that when a requisition came for any regiments, a mount of sound, acclimated, trained, and colored horses could at once be sent in a solid shipment."

Capt. Pond also objects to the purchase board of three officers as being cumbersome and productive, from the lack of unanimity of opinion which often exists among them, of delay in the transaction of business. He likewise makes some suggestions as to a government breeding station, which subject will be noticed further on. As to his main proposition, the establishment of a general purchase depot, few will deny its practicability or advantage to the government, provided that the breeding system is not adopted. Leavenworth, Riley, or some other central point or points at which the government reserve is sufficiently large, and which would combine the further conditions of accessibility to horse raisers and routes of travel, cheap forage, and good grass and water, would, of course, be the proper places of such depots. As far as climate goes, we would prefer the cold, bracing atmosphere of Kansas, Colorado, Wyoming, or Montana to more Eastern or Southern regions, irrespective of the advantages they afford as central points. It is well known that some of the best and hardiest animals in the West are raised in the most Northern latitudes of the Territories. But at the same time the expense of extra feeding and shelter during an increased length of winter would render it unadvisable to seek any spot subjected to too great severity of climate. Our idea would be to have several of these depots; one say at Riley, one in Montana (near Helena), and one at some point in the Southwest, accessible to the cavalry stations of Arizona and New Mexico. We would thus obtain a larger surface of supply, save many thousands of dollars in transportation, and have our herds in convenient sizes for handling. If, however, but one central depot be established, the officer in command of it, wherever placed, should be of high rank and long experience in his corps; he should be a *cavalryman, par excellence*, with a thorough knowledge and sincere love of the horse. None other could secure the administration needed to make a success of such an establishment.

The use of the italicized word "cavalryman" does not contemplate an officer "officiously partisan" or bigoted, as to his own corps, but means an officer thoroughly imbued with a love for good horseflesh, an interest in the stables, and that cavalry *esprit* which all true officers of the mounted arm must possess. He should have the supreme immediate control of his depot, and should, with his command, be entirely separated from service with any other corps, as far as the duties of his garrison are concerned. The attempt to amalgamate the functions of the several arms has caused some of the most deplorable defects that have ever existed in our army, and would be fatal here. Given such a commanding officer, he should be assisted by an able corps of subordinates, selected in the different grades for their interest and skill in everything pertaining to the horse. These latter officers should, with the exception of the necessary guard and court martial details, have nothing but the legitimate duties of such a depot to occupy them. A battalion of cavalry large enough to furnish, if possible, one private trooper for each two horses at the depot, should be barracked in proximity to the stables, and limited, like the officer, as much as possible to the duties strictly incident to the care of the horses and stables of the depot.

A purchase board composed of three cavalry officers of recognized expertness and ability for such a position should be established, and should be as nearly permanent as possible. Four years is the least limit which such a board should have, in order that it may thoroughly learn the markets, merits of the different dealers, and, generally, those things about their business which only long experience will perfectly teach.

An officer of the quartermaster's department, or one acting as such, might be attached to this board as a fourth member, to be charged only with the disbursements incident to purchase.

Ready money should be paid on the spot for each animal bought.

To this depot it is believed that in a short while an ample number of horses, fulfilling the required conditions, would be brought each year. If there proved at first a deficiency due to a lack of horse breeders in the vicinity, this would be remedied ere long by the increase in the number of such breeders which the inducements of the market thus afforded would give rise to.

Animals should, in our opinion, be bought into the depot at the ages of three and four only. The minimum of height for the first age should be about $14\frac{3}{4}$ hands, and for the second 15 hands. They should correspond to the conditions laid down in the regulations for purchase, in all particulars, save those of age, height, and weight, in which the figures should of course be decreased for the younger age.

They should be shown broken to the saddle when bought, and should possess that build which in a young horse gives promise, to the experienced eye, of fine high action—the action needed for a typical cavalry charger. They should be kept one year at the depot, where they could be thoroughly bitted, broken to cavalry gaits, assorted in colors, and shipped to the different regiments thoroughly fit for service. These animals thus purchased could, both on account of less age and the fact that dealers could afford to sell reasonably to so large and steady a market, be bought at a large reduction on the present prices for full-grown horses; let us say at an average discount of 25 per cent., which is, we think, a fair estimate. Then a six-year-old, say, costing, at existing rates, $140, would come, at three or four years, to something like $110. Adding to this the cost of keeping the animal one year at the depot—which should be very small in a country of cheap forage like say Kans. s—we can at once see the saving in a pecuniary way to the government.

Of course, in shipments made from the depot to remote cavalry stations, the large transportation charges would materially cut down this saving. It must be remembered, however, at the same time, that the present cost of shipments from the East to many Western points would thus be saved.

I advocate purchase at the ages of three and four, because at five, or older, a horse is generally too confirmed in habits and disposition to receive the highest benefit from such drill and training as this depot would afford, and younger than three, the colt would have to be kept at least two years at the depot before being fit for service; and the expense and trouble of keeping and educating him during this time would render purchase at such age undesirable.

It will be observed that the system just proposed would send some four-year-olds into the different regiments, but unless they be called upon for an unusually arduous campaign immediately after their entry into service, this objection will not be found a serious one.

It would, in case such a depot is really created, be wise to establish it with a view to permanence. The stables and barracks should be durably built and judiciously planned. The former should be no makeshift "shanties," but commodious, well-ventilated buildings—stone if possible—with good floors, improved mangers, loose boxes, convenient hay, grain, and saddle rooms; in other words, stables built with all available precautions for the health and comfort of the animals they contain. It would take but a trifling additional outlay to secure these and make them all that model military stables should be.

At least two large riding halls should be erected, as they will be absolutely necessary for winter work. Steeple courses and riding tracks could, of course, be laid out anywhere and without much outlay of time or trouble. Whether Congress would appropriate a sufficient sum for all of the buildings needed would seem to be the only question upon which the ultimate success of the establishment would depend. The absolute amount needed to start it would not be large, in fact, would be actually insignificant in comparison with the value of the results it would secure to the government. Supposing no special school of cavalry to exist, the officers, below the rank of field officers, stationed at the depot should have the benefits of a course in veterinary surgery and horse shoeing. Nowhere better than at such a place could opportunities be found by our officers to prosecute those rare but valuable studies. They could, under the instruction of several of our best veterinary surgeons, specially detailed for the purpose, gain here that technical and practical knowledge of these details of their profession which would not only add to their efficiency as mounted officers, but which would stimulate a professional interest in such matters that would be of incalculable benefit to our mounted service. It is hard not to digress and go into all the possibilities in the way of professional advantages which could be derived from such an establishment properly managed. It could, leaving out other considerations, remedy nearly all the defects which, despite our many practical accomplishments derived from West Point and frontier training, now exist in our technical knowledge of the horse and his treatment.

Each animal, as soon as he is brought into the depot, should be turned over to a trooper, who, if possible, will be specially and permanently in charge of him, as regards grooming, handling, and riding. The tempers and capacities in horsemanship of the men should, in as large a measure as possible, determine their selection for the different horses. The latter, at first equipped with the saddle and snaffle, should be drilled for some weeks in the school of the soldier (in small squads), in the halls and in the riding schools. This preliminary training should be for the purpose of "mouthing" the horse properly, teaching him obedience to the leg and quiet behavior. In this instruction, therefore, it is requisite that gentle gaits be solely used, and that each drill is under the personal supervision of a careful officer. It is too often found that many young animals sold by Western raisers as first-rate "saddle horses" have a large education still to gain in the rudiments just mentioned.

After these first few weeks of drill, the curb bit is substituted for the snaffle, and troop and battalion drill still further continues the horse's training for the ranks. In the winter, instruction should be carried on in the halls, though, of course, to a more limited extent, and in the spring an occasional tour over the steeple course, commencing with easy leaps, teaches the animal what so few of our service horses are now capable of—the art of going "across country."

At the end of such a year's training can it be doubted that this animal will exhibit a more satisfactory type of cavalry horse than we now ordinarily find in our ranks?

The above is, without going too much into detail, a sketch of our idea of what a general *Depot of Cavalry Remount* should be. With a reasonable appropriation and a vigorous interest in the subject on the part of the proper authorities, such an establishment could not fail to be useful and in all respects *practicable*.

II. BREEDING SYSTEM.

We now come to the second alternative in the shape of a remedy, which is that of a breeding farm, maintained and controlled by the government itself. Such a plan has, undoubtedly, with its many merits, some serious objections. In the first place, if the farm be started on a basis large enough to enable it within the first five or six years to supply from its own stables the entire yearly quota of horses needed for the cavalry service, a much larger preliminary outlay would be required then for establishing the purchase depot. The cost of the number of stallions and mares necessary to commence on such a scale, and of erecting suit-

able stables, etc., for these and their first season's foals, would evidently be the most formidable items of this first expense. Another difficulty would be the lack of sufficient pasturage on most of the reservations which the government now possesses, and which are otherwise suitable for the purpose, to accommodate the large number of animals which would accumulate on the farm at the end of two or three years; and still another, and by no means the smallest obstacle, would be the difficulty of securing the service of officers competent to successfully manage such an undertaking. If there are any officers in the world who possess versatility of talents, and the faculty of making themselves readily expert upon subjects which are difficult and unfamiliar, they are the officers of our own army. But in this particular case, some experience and previous knowledge of the theory and practice of horse breeding are absolutely necessary qualifications for the officer in charge of the farm; and of course they would be most desirable attributes on the part of his assistants. It is probable that officers with these requisites can be found in our cavalry, but they do not grow on every bush, by any means. A careful selection of the officer in command, at any rate, would be a *sine qua non* of success. An officer of rank, of some experience and ability in such matters, a true horseman himself, and one bringing a sincere interest into his work, would, with reasonable facilities at his command, insure good results from the farm; one placed in command of it simply through favoritism, or because "his high rank entitles him to it," one indifferent to the horse and without enthusiasm as a horseman, is equally certain to insure a wretched failure.

The commanding officer should be privileged to visit the farms, and study carefully the systems of some of our noted breeders, like Gen. Harding, of Belle Meade Farm, Tenn., Mr. Alexander, of Woodburn Farm, Ky., and others. He should learn from such men and the large Western raisers all the points regarding breeding, feeding, hygiene, etc., which would be valuable to one starting in such a business without a thorough experience. He should have the services of the most competent veterinary surgeon in the service as his adviser, and should neglect nothing which could assist his own knowledge in the administration of the farm. He should give his stables, paddocks, and the training grounds his daily personal attention, and should be competent to detect and remedy at once any defects here or in the general management of the mares and foals. Could such an officer be found, the objection last cited to the farm system would largely disappear.

To offset the drawbacks to this system is the fact that it would, properly managed, give us the very best quality of mounts obtainable for cavalry service, that a farm of moderate proportions could easily supply the yearly requisitions from the various regiments, and that when fairly started such a farm, as we shall attempt to show, will prove more economical than either the present purchase system or the one discussed in the beginning of this paper. There is, too, a powerful element of success for the breeding system in the favor which, we believe, the lieutenant-general of the army bestows upon it. It is understood that it has received his approval on numerous occasions, and that it has been his wish for some time to establish the farm at Fort Riley. Under encouragement from so high a source, and with the advantage of so good a selection as to site, this farm would be born under most happy auspices. Given an appropriation sufficient for a proper start, a good location with abundant pasturage, a *competent management*, and the *favor* and *influence of the proper authorities*, and I would unhesitatingly declare for the breeding system against any other. The scale of this article will not admit of any elaborate inquiry into all the details of horse raising, and still less of the cost of buildings, feeding, fencing, etc., in connection with so large a breeding establishment. A discussion *in extenso* of this sort would, besides, be beyond anything which my experience would attempt. I can claim, however, besides a constant interest in the subject for some years past, the advantages of a close attention to foreign military breeding systems and of extensive correspondence, personal and otherwise, with some of the most famous raisers in Kentucky and the West.*

The following ideas as to a farm suitable for supplying our service horses are based, therefore, largely upon the experience of others. I have sought information only in the most reliable quarters, and have rejected much that, while applicable to the luxurious circumstances of wealthy raisers, or to the raising of fancy thoroughbred stock, would be unsuited to the conditions of any farm for the service. The object to be attained by the latter should be, as we take it, *the rearing of a good-sized, hardy, spirited, and sound type of cavalry horse at the least possible expense to the government.* A suitable place having been determined upon, the first question we should naturally ask would be, "On what scale shall we commence?" or, in other words, "What yearly demand is our farm to supply?" Looking into the quartermaster-general's annual reports, we find that the yearly average of horses required for the cavalry is about 1,000. The first query would then be, 1st: "*In order to supply a quota of 1,000 animals per year, what number of stallions and mares shall we purchase as a beginning?*"

It is evident that we must be limited by economy on one hand, and, on the other, should commence on a footing sufficiently large to make the farm the sole source of supply for the service, within a reasonable number of years.

We think that both of these conditions can be most nearly fulfilled by commencing on a basis of 1,000 brood mares and 20 stallions. This will give 1 stallion to every 50 mares, which is accepted as about the best proportion for strong offspring.

Leaving aside for a moment the quality and cost of these, let us examine the possibilities as to issue from this number of breeders.

Let us suppose the animals put on the farm before the May season of the year, in time to be served by the stallions on the ground. We will then calculate upon a "get" for the next spring. In this calculation we will premise that 75 per cent. of the mares—a moderate estimate—will successfully foal. Allowing a margin for disease and accidents to the young animal after birth, let us say that 70 per cent. of the mares will each year produce foals which will afterward reach the age of 5 years and be fit for cavalry service.

With 1,000 mares and 20 stallions this will give us, for the successive years:

	Yearly No. of Foals.	Total on Farm (original Mares, plus Foals).
End of 1st year.	700	1,000+700=1,700
" 2d "	700	1,700+700=2,400
" 3d "	700	2,400+700=3,100
" 4th "	700	3,100+700=3,800
" 5th "	700	3,800+700=4,500

The first season's get are now four years of age, and the fillies of that year are, therefore, old enough to breed, in addition to the original mares. Let us suppose that these fillies represent 50 per cent. of the 700 of that season. Counting their progeny in at the end of the sixth year (one year from the time they are put to the stallion), and doing the same for the fillies of the following years, as they successively arrive at the age of four, we have:

	Yearly No. of Foals.	Total on Farm (original Mares, plus Foals).
End of 6th year.	945	4,500+ 945= 5,445
" 7th "	1,170	5,445+1,170= 6,615
" 8th "	1,415	6,615+1,415= 8,030
" 9th "	1,660	8,030+1,660= 9,690
" 10th "	1,905	9,690+1,905=11,595

The next season we get the grand issue of the first season, and so on.

We have now, at the end of ten years, arrived at an average of 1,900 foals yearly.

Estimating 50 per cent. of these to be colts,* and rejecting two fillies (which are unfit as future material for cavalry), we now have, in other words, an annual yield of about 1,000 *colts*, or a number just about large enough to supply the quota of geldings needed for the service each year. We also see that we would have at this time a total of 11,595 on the farm, supposing us to have kept all our original stock and its progeny. But we have *not* done this; we have replaced some of our original mares and stallions by younger breeders of their own families, and we have supplied, in the meantime, some 1,700 fine, well trained, five-year-old geldings to the service—the product of the colts born during the successive years, from the first to the sixth, inclusive.

Evidently, however, 10,000 odd animals is too large an establishment for the supply of only 1,000 animals yearly. The unnecessary surplus is due to our having kept on hand all the *fillies* born in the different years. As these are not fit for cavalry use, and since only a comparatively small number are needed each year to replace the older brood mares as the latter outgrow their usefulness, it is evident that we must dispose of this surplus. There are two ways of doing so—either by public sale (when they become yearlings say), or by following the example of foreign cavalry services and utilizing both mares and horses for the ranks. By this last method everything would be fish that came to our net, and our production on the farm reduced to the most economical scale.

We will suppose, however, that the present system of using only geldings be carried out, and that the surplus of mares be disposed of by the other alternative of sale. Our next question, then, would be:

2d. *What average number of animals would we have to maintain on the farm at a time to produce, annually, 1,000 colts?*

Reckoning always that about 50 per cent. of each year's issue *are* colts, we find that a yearly number of, say 2,800 mares and 50 stallions is necessary to keep up this supply.

Supposing the fillies, except those needed as breeders, to be sold as yearlings, and the males to be sent to their regiments at the age of five, we should have an average yearly total of between 8,000 and 9,000 animals present on the farm—figuring approximately.†

It is observed that the plan sketched above necessitates the system of in-breeding, through and through. This we would by no means consider an objection. Few of the best authorities on horses now so regard it, and some of them are even outspoken advocates of it.

Mr. Brodhead, manager of Mr. Alexander's farm, of Woodburn, Ky.—one of the most successful raisers in the world—says, in answer to an inquiry I made of him recently on the subject: "I like in-breeding; it is the only way to establish a type. On common mares you could put three or four crosses of stallions of the same family and have the same characteristics. In fact, this could be done indefinitely by judicious selections. You can hardly in-breed too much to a good thing." Besides being unobjectionable, as far as its effects on the quality of the breed is concerned, in-breeding is obviously the most convenient and economical system for the government, as it avoids that constant attention and care which the plan of crossing would require in the separation of animals, keeping records of pedigree, etc.

The next question which suggests itself is:

3d. *What character of stallions and mares (as regards blood and price) should we select as breeders?*

This is the point on which the advice of experienced breeders is more conflicting than any other. Some recommend thoroughbred stallions, of a certain strain, upon half-bred mares; others, the same stallions upon three-quarter bred or thoroughbred mares. One urges the importation of "Cleveland Bays," to be crossed with American mares; another, thoroughbred American (not imported) stallions upon cold-blooded females. The last is the plan proposed by Mr. Brodhead, and the one which seems to us best. Keeping in mind the type of horse needed for cavalry purposes—strong, big-barreled, and hardy—we can easily see the objection to a *full* strain of pure blood, carrying with it, as it usually does, a nervous, high-strung temperament, sensitive organization, and light build. It is also evident that an opposite extreme—that of a stolid, dull, heavy-limbed brute—is equally to be avoided. What we want is that judicious blending of blood which will produce the proper combination of the qualities of the two types—the spirit, activity, gracefulness of the one, with the hardiness and strength of the other.

If we select our sexes from American thoroughbreds, the best method would probably be to buy up racing stallions retired from the turf for accident or other cause. Even those retired for age would for many years answer our purpose, as up to twenty, and often after, their breeding properties would be unimpaired. A requisite number of such animals could readily be procured at a cost of from $1,000 to $1,500. The 20 stallions which we would need in the beginning would thus cost us between $20,000 and $30,000.

As for type, we would select some such get as that of Phaeton, Ten Broeck, or King Alfonso,* which strain is abundant in Kentucky to-day. It is noted for its strength, speed, docility of temper, and perfection of form.

In choosing our mares to breed to such stallions, we would advocate cold-blooded ones for the following reasons: they are cheaper, they give, with such a cross, the happy medium for cavalry use spoken of above, they breed more surely, and require less attention than thoroughbreds. We could buy the proper type of such mares, good sized, sound, strong, well proportioned, and good breeders, for from $150 to $200, in Kentucky or Tennessee. Thoroughbreds would cost two or three times as much. These mares should be bought from 4 years of age up to 10. They would in health be perfectly adapted to breeding up to about 22 years of age. Served by a stallion of about 16 hands, mares of about 15½ hands would probably give us the best size for cavalry. They should be chosen from a region possessing a large portion of well-gaited saddle horses, such as the two States above named. The issue in such a case would be much better saddle material than if their dams came from Western ranges, where the stock is but rarely well broken to the saddle. The perfect saddle gait has to be *bred* in the animal, and nowhere is it really inherited except in those States where the raising of saddle horses has been a long-established business.

As for any fears, on climatic grounds, regarding the health or breeding properties of animals taken from the Eastern States to Western ranges, we do not believe them to be well founded, as the testimony of many Western raisers of repute who have tried the experiment asserts it to be a safe one. Mr. W. H. Raymond, a large raiser near Virginia City, Montana, who has imported some very fine Kentucky stock, and who for some years has been not only one of the best posted but one of the most successful breeders in the West, writes me that he has brought Kentucky mares upon his farm as late as November, and that they wintered perfectly without any other feed than that furnished by the range. Others have told me similar experiences. Of course, in individual cases it may sometimes prove otherwise, but believe the liability to accident from change of climate alone to be extremely small. Our breeding farm should be established at such a season that the mares may be served by the stallions in April or near the 1st of May. About the last period would probably be the best for a climate like that of Riley.

From the above calculations, it is observed that our outlay on the number of breeders (stallions and mares) necessary to start our farm on the proper basis is only about $200,000—a sum but little in excess of the yearly appropriation for cavalry and artillery horses as at present purchased (the sum for 1884 was $186,731, and for 1885 $203,370).

The last question we will consider is:

4th. *What would be the cost of rearing an animal on such a farm as we have designed?*

The answer to this naturally involves, to a large extent, the practicability of our undertaking, as far as pecuniary considerations go. To an enthusiast in horse culture it will be difficult to discard all idea of fancy stables, model paddocks, and luxurious appliances. His love for a fine animal would naturally prompt him to bestow a refinement of care and attention upon him and to surround him with all the elegance which could gratify a fastidious taste. But in our case no such fancies are allowable. The problem before us is to get the best possible mount at the smallest possible expense. In the case of a purchase depot with but a couple of thousand animals, improved stables and their accessories would probably have been feasible, but here, with some 8,000 or 9,000 horses, they could not be thought of. It is well known that many raisers in Kentucky, and in even the colder regions of the West, make their stock "rough it," in the strictest sense of the word, all the year through. Neither mares nor foals are ever stabled on their farms, and in some cases even the young animals after being weaned are left to get their living from the pasture during the following winter.

Mr. Raymond, who has already been quoted above, says: "As to cost of raising a gelding, it would not cost any more than to raise a steer, after he is weaned. I never feed them. The best mares I have, have not been fed 10 bushels of oats in 10 years. They simply run at large on the range." It must be understood

* Among those in Kentucky, I am especially under obligations to Mr. Brodhead, of Woodburn Farm, and Mr. Bailey, of Midway, for a great deal of valuable information.

* The word "colt" is often very loosely applied. The offspring of the mare is, properly, the *foal* immediately after birth. From that time the males are *colts*, and the females *fillies*, up to the age of five, when the animal of each sex is said to be grown. The male is then the *stallion*, *horse*, or *gelding*, and the female the *mare*.

† As has been suggested for the purchase depots, there might be two, or even three, of these farms distributed in such parts of the country as furnish the best advantages, thus dividing our herd into smaller and more readily managed bands. The French maintain on this principle three cavalry *haras*, or breeding farms, with excellent results.

* These stallions are said to impress themselves wonderfully upon their progeny. Phaeton died in 1872; Ten Broeck and King Alfonso are still living, and are the property, respectively, of Messrs. Harper and Alexander, of Kentucky. King Alfonso is said to stamp his get even more surely than Ten Broeck, and is a very sure breeder. His picture, sent me by Mr. Alexander's agent, is before me as I write, and shows the perfect model of a cavalry horse. The following is his description in Bruce's Stud Book:

"King Alfonso is a red bay, 16 hands, with a star in his forehead, and is one of the truest and best shaped horses in the world; his head is plain, but well shaped and set upon a good, strong, muscular neck, with wide, deep throttle, the shoulders oblique, broad, and well placed, and covered with suitable muscle; the chest is well shaped and full, with great depth of girth; the body full and round, with the finest back, hip, and loin ever put on a horse, being broad, well rounded, and slightly curved. He has great length from the point of the hip to the whirlbone, thence to the point of stifle and hocks, being full of strength and muscle which run into broad, powerful hocks, the legs and feet being sound and good. His temper is of the best. In addition to his double cross of Glencoe, he has the waxy blood through Web, Whisker, and Whalebone, and is inbred to Sir Archy and imp. Shark, with many crosses of Herod and Eclipse in collateral branches."

In addition to the above, the eye of a cavalryman would note the following features:

His back is short and straight, with the saddle place beautifully situated, it being as nearly as possible in the middle of the back. He has plenty of room beneath the belly. In other words, his back is a powerful one, and little apt to be sored by the saddle; and the length beneath tells of speed and free action. Such a horse can never be awkward or "tied up" in his movements.

His legs are models. His fore leg is not, as with many racers, too long for a military saddle horse; it is flat, finely muscled, and with a proper proportion between the relative lengths of fore arm and lower portion. His legs stand well under him, and the hind ones, with the same beauties, in point of flatness and muscle, as the fore ones, are exactly proportioned in length to the latter. They are just long enough to serve their purpose as powerful propellers, and not sufficiently so to raise the hind quarters beyond the line of symmetry of a flat back.

that this gentleman is a breeder of thoroughbred, catalogued horses. He pursues his business, too, on a large scale and in a climate by no means mild in winter.

Despite the above authority, however, I am not convinced that this system of raising should be strictly imitated by the government. Many other breeders acknowledge that the system of no feed and no shelter during the whole year prevents the fullest and most perfect development of the animal. They assert that a very hard winter will, under such circumstances, stunt a youngster, and we know they are occasionally lost through exposure in such seasons. A certain amount of food and shelter is, we may say, then necessary for both the young and old animal. Accepting this as a premise, I would suggest the following system in rearing:

Our farm should be divided into large fields, capable, each, of containing, say, a couple of hundred mares. The stallions should have each a box stall, and there should be suitable corrals in which mares might be served and young animals handled. After the mares have been served in the spring, let them be turned to grass in their respective fields. If the latter are sufficiently large, and the grass good, they will need little other food until, say, December. At this time their condition of pregnancy and the state of the grass would render an additional supply necessary. In each field there should be substantial sheds or open stables, the opening toward the south. These should have hay racks and feed boxes and be large enough to contain all the animals in that field. They would furnish shelter in the winter or seasons of storm. In these the mares are now driven each evening. They receive a small feed both then and in the morning, and are turned out to pasture again the following day. Each of these fields should be under the constant care of an experienced non-commissioned officer, assisted by a proper detachment of non commissioned officers and men. This system of sheltering and feeding the mares will continue until the grass is good in the spring. When, about this time, the animal shows signs of foaling, she is taken to a loose box where she is kept for a day or so after delivery. She and her foal are then turned out to pasture, and little further attention need be paid to either until the fall, when the youngster is weaned. The latter, deprived of its mother's milk, should from this time until the following spring have a regular daily feed of hay and grain, for its proper growth at this period is of the utmost importance. It is assigned its separate place and manger in one of the open sheds. All the fillies (except those retained for brood mares) should be sold the following spring, as already suggested. The yearling colts are at this time again turned to pasture and left entirely to grass (if it be abundant enough) until the succeeding fall. This treatment should be followed each year until the last six months previous to their shipment to the regiment, which would probably be in the early summer. During this period (the animal has, of course, been previously broken) they might with advantage have the feed increased to the regulation allowance and receive daily grooming. This would fill the horse out and permit his entry into the troop with a fine exterior.

Supposing the forage supplied to be cheap, say grain at 1 cent and hay at 5 cents per pound (a probably fair rate to assume at a spot where such large quantities would be sold at contract prices), and calculating that a half ration of grain and two-thirds ration of hay be fed the animals daily during 6 months the first year, and during 5 months each succeeding year, we find that the actual maintenance of the animal under the above system has cost, up to the time he is sent to the regiment, only the modest sum of $85. This calculation leaves a small margin and includes almost the *total* actual cost of the animal himself, as on a government farm the labor would count for nothing.

Compare this method, which gives us a real cavalry horse, well broken, and of blood and soundness which we can ourselves vouch for, with the present one, by which, *at an increased cost of from $40 to $90*, we obtain an unknown animal, of indifferent appearance and inferior build, and, not rarely, found an entire stranger to cavalry gaits—and we can decide without much reflection which is the better of the two. Can there be any question about it, or any denial of the assertion that a cavalry of 8,000 men under a rich government, and in a country of 12,000,000 odd horses, should be better mounted than our own now is? Much has been urged in favor of pony stock for frontier service.

The opinion of most cavalry officers of the widest experience in this service is that its claimed superiority to the American article is unfounded. Many of us who have scouted in a rugged, mountainous country—in which this superiority, if it exists, would be made more apparent than under other circumstances—have seen the American animal kill his one and two ponies in a summer. For all service off the frontier the latter are evidently valueless from any standpoint.

What we want, then, for the cavalry is a really good type of American horse, and I believe that the method of producing him which I have briefly sketched above is a cheap, practical, and satisfactory one.—*Jour. Mil. Serv. Inst.*

OVERPRODUCTION DISCUSSED.

By Geo. F. Stark.

1. The term "overproduction" does *not* mean a production of more things than men *can* consume, but a production of more things than men (at any given time) *do* consume.

2. As any deed done implicitly proves the doer's ability of doing it, so does actual overproduction prove man's power of producing more than what he *must* consume for life's sake.

3. Man *always* was possessed of this gift of overproductiveness, although in that most remote past when the ancestors of our race were roving savages it was dormant; man then being used to relax from his exertions as soon as his most immediate wants were supplied.

4. Men did not give up their lounging about of their own accord, but had to be *forced* into producing more than they consumed. While in their rudest state belligerent tribes were used to eat their captives, in course of time the latter were saved and enslaved. Thus, from the discovery of man's being endowed with overproductiveness, ancient slavery sprang.

5. Slavery benefited both parties concerned, giving leisure to the masters, and developnig strength, perseverance, and manual skill in the slaves, whose enforced diligence not only supplied their own limited wants and those of their masters, but even left a surplus of wealth to be accumulated.

Thus, ancient slavery first made man's dormant gift of overproductiveness develop into *actual* overproduction.

6. The reader is invited to survey universal history from this aspect, when he will see that it is indeed to these two mighty agents, viz., overproduction and leisure, both of which having sprung from man's natural gift of producing more than what he *must* consume, that all civilization is due.

7. Overproduction first came into play at the slave master's cruel bidding. Leading to progresses not intended, and being by them in turn enhanced into still larger overproduction, it has ever since been working wonders, for all discoveries and inventions, all sciences and arts, were and are possible only through over production's aid. Its work is the wealth of nations, having slowly risen in ancient times, somewhat quicker in the middle ages, and which is so enormously fast increasing in our days. But overproduction's greatest achievement is this: It has made the coercive power to which it owes its existence change from ancient battle slavery into serfdom in the middle ages, from that into the modern wage system, in which latter there is no coercion at all save that of want.

8. What is it that nowadays prompts a workingman, being free, to go to his fellow man, asking him for employment? It is merely the fact of the workingman's being possessed of no other goods but his productive power, which he, consequently, must sell every day in order to keep alive. The price he gets for exerting his strength and skill during a certain time to-day depends on what it costs to reproduce this strength and skill for to-morrow, being regulated at that by the law of supply and demand. And what then makes an employer undergo the trouble of buying human productive power? Why, it is because of its overproductiveness, thus adding more value to the raw material, etc., than what he pays out in wages.

9. What is the consequence? This it is—that all the wage-working men, women, and children the world over cannot buy the value they are creating for the wages they receive for their work; they can buy a part, though, leaving the rest for the non-wage-workers, whom, in order not to become diffuse, I will shortly call the employers. Will the latter buy their full share of the products?

10. No. Though they may have the means to buy it all, they have use only for a moderate part of it, for their number is comparatively small, their manner of life, as a rule, very modest. Consequently they, too, fall short of clearing the market. An immense quantity of goods of all descriptions remains unsold, stocking magazines and stores, depressing prices, discouraging speculators, paralyzing industry, throwing thousands of laborers out of work. It is at this stage of the overproductive process that the general public first perceive that there *is* an overproduction.

11. Why is it that people never spoke of overproduction in former times? The reason is obvions. When all or nearly all of the goods were being made by hand, the total amount of production was much smaller, the rich lived more gorgeously. Then the whole, or almost the whole, of the surplus passed directly into the hands of the rich. No stores being stocked by an over abundance of goods, and the progress of operations not being hindered, no overproduction was then visible. Moreover, political economy was unknown.

12. Among the consequences of early overproduction exchange plays an important part. That there could be no exchange as long as every individual or group of individuals, family, tribe, produced no more than every one consumed, need not be proved. When slave masters took the matter in hand, the tribes commenced to exchange goods with one another, which exchange developed into commerce. However different the commercial destinies of the individual countries be in particular, they have certain general features in common. When a country enters into connections with advanced nations, it imports fabrics at first, later workmen and working implements still later implements alone. Next at home discoveries are made and, natives trained, domestic industries begin to develop; gradually the country will supply its own markets, shutting out foreign import more and more. In course of time it commences to export some of its fabrics, finally its industries depend completely on opening foreign markets. This is the epitomized commercial history of every land on earth; some countries having already arrived at the last stage, others marching fast in that direction under our very eyes, still others awaiting their day from the not distant future. *There is no land on earth, however barbarian it be at present, which will not some day be as industrious and anxious to export its products as the most advanced country to-day is.* Thus when the exporting fever will have reached its climax, it must necessarily wind up with paralysis, every country then having again to trade with itself alone.

13. But is it not just the impossibility of profitably disposing of the products of industry at home that to-day chases our manufacturers and merchants round the earth in search for foreign markets? Well, then, at some time in the future these foreign markets will be closed, while the domestic markets will be overstocked, the factories shut down, large populaces idle, restless, and without subsistence, and a universal stagnation prevailing, compared to which the worst business depression we have ever experienced might be called a boom. Thus overproduction, leading society through a series of transitory business depressions, must end in absolute non-production.

14. Whole populaces being in great distress, not to say in immediate danger of life, are not usually inclined to take things calmly. Ought not we, therefore, while yet in safe distance from the however fast approaching event, discuss these matters *until a remedy is found and agreed upon* to avoid the impending danger?

15. Is this danger perhaps due to an altogether too far pushed division of labor? No; for division of labor renders every worker so much more skillful in his particular calling, and skill can hurt no one. Or is it machinery, then? No; for machinery facilitates man's calling to be a creator, a demi-god on earth; its tendency is to elevate, not to depress him. Or is perhaps "*protection that does not protect*" responsible for the mischief? How could it be, when overproduction in-

DATA CONCERNING OCEAN STEAMERS.

The data which follows concerning some of the principal steamers lately built, is from Mr. W. John's paper on Atlantic Steamers, read July 29, 1886, with slight corrections in certain data, for which we are indebted to Commander French E. Chadwick, U. S. Navy.

Name.	Length	Breadth	Moulded Draft	Midship Area	Displacement	Indicated H.P.	Speed	Block Co-efficient	Midship section Co-efficient	Prismatic Midship Section Co-efficient	$\frac{D^{2/3} \times S^3}{I.H.P.}$	$\frac{D^{2/3} \times S^3}{I.H.P. \times \frac{Vent.}{10}}$	Kirk's System. Length of Entrance	Kirk's System. Angle	Coal Consumption. Per Day	Coal Consumption. Per I.H.P.	Cylinders. Diameter	Cylinders. Stroke	Boilers. Heating Surface	Boilers. Bar Surface	Working Pressure
	Ft. In.	Ft. In.	Ft. In.														Ins.				Lbs.
"City of Rome"	542 6	52 0	21 5¼	1,031	11,230	11,890	18.235	.649	.925	.702	255	201.3	161.27	8 deg. 29′	185	2.2	3 to 46 3 to 86	72	29,258	1,398	90
"Normandie"	459 4	49 11	19 9¾	892	7,975	6,959	16.66	.614	.901	.681	285	219.5	146.41	8 deg. 44′	148	2	3 to 35 7-16 3 to 74 7-8	67	21,404	756	85.2
"Furnessia"	445 0	44 6	22 2½	898	8,578	4,045	*14	.682	.903	.755	284	273	108.7	10 deg. 28′	97	2.2	49—100	66	10,306	440	90
"Arizona"	450 0	45 1½	18 9	758	5,415	6,300	17	.589	.895	.658	269.2	217	153.79	7 deg. 30′	..	..	1 to 62 2 to 90	66	....	..	90
"Orient"	445 0	46 0	21 4½	904	7,770	5,433	15.578	.621	.919	.676	270.8	225	144.17	8 deg. 21′	..	..	1 to 60 2 to 85	60	....	..	75
"Stirling Castle"	420 0	50 0	22 3	900	7,600	8,206	18.4	.569	.889	.639	286.8	233.7	151.3	8 deg. 22′	..	..	1 to 63 2 to 90	66	21,161	757	100
"Elbe"	420 0	44 9	20 0	807	6,350	5,665	16.571	.591	.901	.655	275.5	229	144.6	7 deg. 56′	..	..	1 to 60 2 to 85	60	....	..	..
"Pembroke Castle"	400 0	42 0	17 0	648	5,130	2,435.8	12.25	.623	.9	.692	284	258	122.9	8 deg. 49′	44	1.7	43 and 86	57	7,896	288	90
"Umbria" and "Etruria"	500 0	57 0	22 6	1,090	9,860	14,321	20.18	.538	.893	.637	200	191.8	184	9 deg. 52′	315	2.1	1 to 71 2 to 105	72	38,817	1,000	110
"Aurania"	470 0	57 0	20 0	1,020	8,800	8,500	*17.5	.575	.942	.629	268	204.6	170	8 deg. 38′	215	2.2	1 to 68 2 to 91	72	23,284	1,101	..
"America"	432 0	51 0	26 7	1,272	9,550	7,354	*17.8	.57	.935	608	345	265	169.3	8 deg. 32′	185	..	1 to 63 2 to 91	66	....	882	..
"Oregon"	501 0	54 2	23 8	1,150	11,000	13,300	18.3	.560	.849	.67	227..	190	164.3	9 deg. 30′	310	2.2	1 to 70 2 to 104	72	38,047	1,428	110
"Servia"	515 0	52 0	23 3½	1,040	10,960	10,300	*16.9	.610	.861	.71	231	192	145.3	10 deg. 42′	205	2	1 to 72 2 to 100	78	27,483	1,014	..
"Scotia, P. S."	369 0	47 6	19 9	867	6,000	4,622	13.5	.605	.92	.65	208.	186	126.8	13 deg. 21′	168	3.6	2 to 100	144	....	..	25
"Alaska"	500 0	50 0	21 0	949	9,210	....	....	.614	.904	.679	..	....	160.23	8 deg. 2′	..	..	1 to 68 2 to 100	72	....	..	100
"Aller"	438 0	48 0	21 0	907	7,447	7,974	17.9	.590	.890	.658	277	225	150.8	8 deg. 10′	..	..	1 to 44 1 to 70 1 to 108	72	22,650	790	150
"Ems"	430 0	46 10	20 7½	877	7,080	7,251	17.55	.593	.907	.652	273	223	149.4	8 deg. 40′	..	..	1 to 62 2 to 86	60	19,700	780	100

*Mean speed of a voyage across the Atlantic Ocean.

—*Army and Navy Journal.*

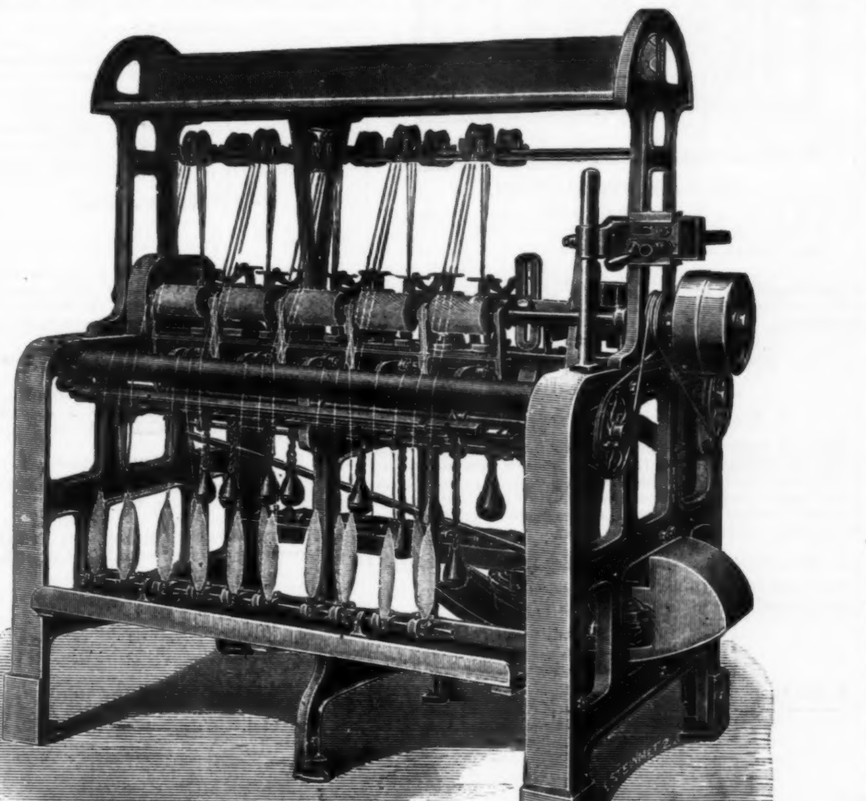
volves not only this country of ours, but the whole community of commerce, *i. e.*, all civilized countries, among whom there is one particularly blessed with the most absolute "*free trade that does not free*" it from the self-same evil! Why, then, it must be the rum trade, and could we but succeed in making all laborers the world over to become enthusiastic hydropathists, business would soon brace up. No, my friend; for, although the cause of temperance when viewed from a *moral* standpoint is surely a godly one, *economically* considered, it cannot bridge the chasm gaping before our feet.

16. If we honestly wish to solve the urgent problem, what is the use of going about the bush? What must needs be abolished is overproduction itself, viz., "a man's producing more value than what he receives in wages," or, if you please, "a man's receiving less value in wages than what he has produced by his labor." The *curse* of overproduction is to be banished only by introducing the *exchange of strict equivalents* into this modern industrialism of ours; while the *blessings* of the overproductive process, *i. e.*, far-pushed division of labor, machinery, abundance of products and easiness of producing them, thus affording *moderate* work, plenty of leisure, culture, and refinement for *all*, may be still secured; yes, even further developed. It is man's wonderful natural gift of overproductiveness that, having been long ago brought into actual play, has gradually led the naked savage of yore to become the highly civilized man of to-day, and it is the same power that will lift society into a still higher state of existence.

DOUBLING WINDING FRAME.

THE winding frame illustrated is exhibited at Manchester by Mr. Joseph Stubbs, of Mill Street, Ancoats, Manchester. It belongs to a well-known type of machine, the object of which is to wind two or more yarns side by side on a bobbin. The yarn to be wound comes in cops from the mule, or occasionally on bobbins from the ring spinning frame, and after it has been laid on the bobbin it goes to be "doubled" or twisted into a thread. The greatest use for doubled yarns is in the manufacture of sewing thread and of Nottingham lace. Sixfold sewing cotton is made of three strands laid together, each strand consisting of two yarns previously twisted together in the opposite direction. Glacé thread, on the contrary, is composed only of three yarns twisted together at one operation, and in the illustration the machine is shown winding three yarns on each spool in readiness for this manufacture. The yarns pass through slots in a clearer plate to break out all the knots and bad places; then they run over a flannel-covered board, the object of which is to oppose a frictional resistance to their passage for the purpose of pulling out snarls and of causing them to be wound hard on the bobbin or spool. After leaving the flannel board each yarn passes through a detecter eye, and then over a small drum, and down through a guide on to the bobbin. The form of bobbin or spool shown in the engraving is one which has been introduced within the last two or three years, and marks an advance in the cotton industry. In place of the wooden barrel with a flange at each end formerly employed, there is merely a pasteboard tube. On this the yarn is built into a compact mass by the device of giving the guide a very rapid to-and-fro motion, so that it lays the threads at a sharp angle with the tube, and wraps each layer on the one below in such a way that the whole is firmly secured, and can be handled with safety.

Should a yarn break, the corresponding spool is instantly stopped by the action of the detecter eyes, and the broken end is usually found between the eye and the spool, and can then be joined and the spool started afresh. Each detecter eye consists of a wire with a hook or curl at the top and a tail below. This wire rides on the yarn until the latter breaks, when the wire drops, falling into the path of a ratchet, which carries it forward until it strikes a bar connected with a catch. The catch is released, and liberates a brake plate, which presses against the spool, and at the same time brings it out of contact with the drum by which it is driven. The spool is thus stopped and remains stationary until the attendant returns it to the old position, replacing the various parts of the mechanism in the same movement.—*Engineering.*



DOUBLING WINDING FRAME, BY MR. JOSEPH STUBBS, MANCHESTER.

PASSING ONE RIVER UNDER ANOTHER.

QUITE an interesting and novel piece of work has recently been executed at Conde, at a few miles from the Belgian frontier, and that is the passing of the river Haine under the Escaut.

A few words are necessary as to the reasons that necessitated the work. Only recently, the Haine and Escaut crossed each other in the open air within the limits of the city, and at the point of intersection of the two streams it became necessary to dredge almost continuously in order to allow of navigation.

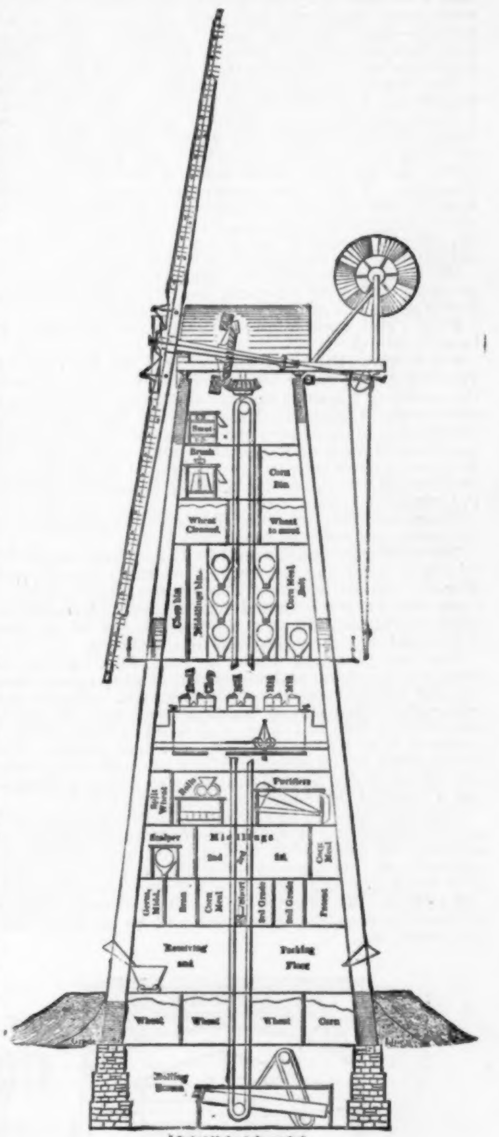
An endeavor was therefore made to direct the course of the Haine and make this river pass under the Escaut (which has been converted into a canal), outside the city limits, by means of siphons. The work was done as follows: The two rivers were first dammed upstream and downstream, and the exact location for the siphons was inclosed with a rectangular structure of piles and planks. After the excavation was completed, the bottom was covered with beton, and given the proper profile for the reception of the siphons. These latter consisted of five iron plate tubes 10·8 feet in diameter, of a total length of 76¾ feet, and composed of a straight portion 43¼ feet in length and two 33½ foot elbows. The tubes were constructed of ¼ inch iron plate strengthened at distances of 3¼ feet with an angle iron hoop. The assembling was done with rivets. St. Andrew's crosses of ⊥ irons placed 3¼ feet apart prevented the tubes from getting out of shape during carriage and putting in place. These pieces were removed as fast as the tubes were lined with cement-covered brick masonry. The siphons were put in place as follows: The elbows, completely riveted and weighing 11,000 pounds, were placed upon a drag and let down into the trench over an inclined plane. The maneuvers were effected through rollers, and two windlasses provided with safety chains. The straight sections, which weighed 22,000 pounds, were let down in the same way, and the three parts were then fitted and riveted together. It took fifteen days to put the siphons in place, and after the operation was finished the laying of beton was continued until the mass reached the level of the bed of the Escaut. The work was completed by the erection of lateral walls and a series of vaults passing in front of the mouths of the siphons and prolonging the lateral dikes of the Escaut.—*Revue Industrielle.*

A GREAT WINDMILL.

WINDMILLS are so common and so useful in this State that we have thought a picture of one of the largest windmills in the world would interest our readers. It is in fact a good sized flouring mill run by wind power. It is situated in the town of Great Yarmouth, England, and is pronounced a perfect success. The plan of arrangement of milling machinery is different from that of the present day. The mill is working on the old principle of a full reduction at the first grind. J. H. Campbell, M.E., of Yankton, Dakota, who has just published a pamphlet on the windmill and its uses for flouring mills, sawmills, irrigation, etc., has arranged a mill with machinery so as to use part gradual reduction with burs and part with rolls.

Of course, it is not necessary to build so large a mill as shown in the engraving, but it is desirable to build as high as possible, for two reasons: First, to receive much more benefit by building a mill up to where the wind is fresh and strong; and second, to get additional storage capacity, and it is much better to have that right in the tower of the mill than put up a building alongside. Milling machinery can also be placed to much better advantage.

A windmill built after the plan shown in the engraving will be 55 horse power with the wind blowing at the rate of 25 miles an hour, and will make 120 barrels of flour easily in 24 hours. It is 11 stories high with basement, and stands 99 feet above the foundation. At the base it is 35 feet in diameter, and 16 feet diameter at the top wall plate. There are five run of burs in it. It has four sails on the patent principle, which are 40 feet and 9 inches long by 12 feet 6 inches wide. The sails are 100 feet in the clear, from point to point. They are provided with striking and regulating gear to



LARGE WIND FLOURING MILL.

keep the motion regular and to counterbalance any unevenness in the pressure of the wind. It is provided with winding gear, so as to keep the sails always square to the wind, and it is so adapted that it can be turned out of wind, if necessary, for repairs, etc. The speed of the sails is set to nine revolutions per minute, and the first motion from head wheel to wallower is two to one. The head wheel is iron, with heavy wood segments bolted around the rim of the wheel, so as to form the inner section of the grip, which is over and around it, and is used, when necessary, to stop the mill.

The milling machinery consists of one smut, one wheat brush, two bolting chests, three reels in each; one corn meal bolt, one break run of burs, one chop run, two run middlings and one run for either middlings or corn, as desired; one set of bran rolls, two sets of smooth rolls, three purifiers, one brush scalper for cracked wheat, and a rolling screen in the basement. It is provided with ample bin storage, so that any part of the machinery may be run and the product dropped without further handling, so as to make use of any and all winds which will turn the sails.

Mr. Campbell says that the first set of patent sails ever used were made in the town of Great Yarmouth, England, which, by the way, his father constructed and put in operation. Thus the writer has an inherited right to talk about the windmill, and we are glad of an opportunity to introduce him to California readers as a devotee to still further progress in the use of wind power.—*Min. and Sci. Press.*

A CONTINUOUS ELECTRIC TRAIN.

AMONG the numerous conditions that universal exhibitions should satisfy, says Mr. Henard, there are two important ones that seem at first sight incompatible. One of these is the greatest area possible for exhibitors, and the other is as little walking as possible for visitors. In fact, in order to attract the public, it is indispensable to bring together all the interesting or curious objects presented by artists and manufacturers, and this cannot be done without considerable space. It is none the less necessary, in order not to discourage visitors (especially women and children), to spare them the fatigue and annoyance of a long walk, and this can be done only by reducing distances.

These inconveniences of an exhibition distributed over a wide surface were perceptible in 1867, and they were only the more so in 1878. It would be useless to renew the experience for the exposition of 1889.

This is a point on which there is a general agreement, since a certain number of railways in the interior of the future exhibition have been provided for. But, although tramways fulfill a part of the end proposed, which is to facilitate visits by diminishing distances, they have two defects: First, the stations take up much room, and, second, the roads are not free, and the fare, however low it be, will always cause a large part of the public to hesitate.

It is for this reason that Mr. Henard has been led to seek a solution of the problem in the establishment of continuous platforms arranged at the level of the ground—true "walking roads," on which visitors can take their place at any moment and at any spot. These platforms would comprise both paying and free places.

The idea of the continuous platform is old, and was suggested a long time ago in America. The American project consisted of a platform moving through the intermedium of rollers, over guides or rails established as a viaduct at a few yards above the surface of the earth, the platform being reached here and there by staircases. This system, if carried out on the Champ de Mars, would have the inconvenience of obstructing the view, owing to its pillars and supports, and, even if it did afford a means of permanent circulation, it would not suppress the incumbrances at the stations.

Mr. Henard suppresses the viaduct, and arranges the platform flush with the earth, as above stated, and renders it accessible at every point of its extent.

Figs. 1 and 2 will allow the general arrangement to be understood.

Fig. 2 shows the two lines proposed by Mr. Henard. The first passes under the Eiffel tower, at 72 feet from the tramway terminus and about 325 feet from the stations of the Champ de Mars and the Seine wharves. It traverses in succession the Palace of Fine Arts, the vestibule of Avenue Rapp, the galleries of Industrial Products, passes near the grand nave of the Machinery Palace, and returns to its starting point through the Palace of the Liberal Arts.

The second line, which is shorter, runs externally to the tower, palaces, and machinery hall.

The platform, which would be 10 feet wide, would be laid upon a continuous train of ordinary freight cars (Fig. 1), which, running in a trench, would form a long, closed *chain* actuated by electricity and continuously moving around at a slow speed, say of 4½ feet per second, or nearly that of a man walking.

The free platform would be everywhere accessible from any direction, and would permit passengers to get on and off without any formality, and without any other effort than simply bending the knee. It would be provided here and there with hand rails to allow of access to it by women, children, and aged people. The entire affair would stop for fifteen seconds every minute, which would be sufficient time to allow of traversing a space of three meters, several times.

Here and there on the platform there would be light pillars supporting a second flooring, protected by an awning, furnished with paying seats, and offering an agreeable resting place to those who had been to a distant point, or who desired "to do" the exhibition without fatigue. Mr. Henard thinks that a certain number of these floors might be inclosed and be used for buffets, cafes, etc.

At certain intervals along the road, foot bridges would be established in order to allow the platform to be crossed without stepping upon it. Besides, a certain number of flying bridges would be erected in order to

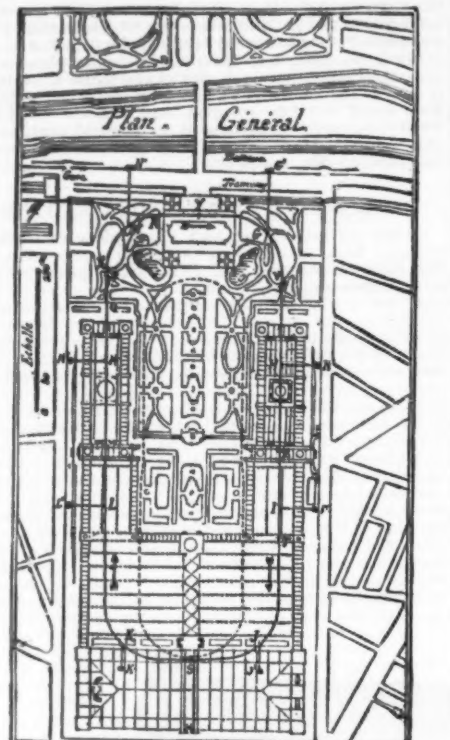


FIG. 2.—GENERAL PLAN.

G, H, I, J, K, L, M, commutator stations. N', G', K', J', H', I', L', M', electric works. S, T, U, V, X, flying bridges.

allow heavily loaded wagons to obtain access to the center of the Champ de Mars.—*La Semaine des Constructeurs.*

ON THE THEORY OF UNITS.

By G. SZARVADY.*

1. MEASUREMENT OF A MAGNITUDE.

WE can compare with each other only magnitudes of the same nature. The result of such a comparison is an abstract number, which expresses the ratio of the two magnitudes. The measurement of any magnitude whatever is the ratio of such magnitude to another one of the same nature taken as a unit.

2. EQUATIONS BETWEEN CONCRETE MAGNITUDES.

Concrete magnitudes are represented by capital letters inclosed within brackets. Thus:

[F] will represent a force.
[M] will represent a mass.
[L] will represent a length.

It has been agreed to express the measurement, f, of a concrete magnitude [F] by the symbol $\frac{[F]}{[F\,o]}$, [F o] being the force taken as a unit. We shall therefore write $f = \frac{[F]}{[F\,o]}$, and in a like manner, $m = \frac{[M]}{[M\,o]}$, and $l = \frac{[L]}{[L\,o]}$. The rules of algebraic calculus may be applied to such symbols as [F], [L], [M]. Let us consider any physical law whatever; the law of Newton, for example, which gives the attraction, f, between two masses, $m\,m'$, situated at a distance, l. It is expressed as follows:

(1) $f = (K)\,\frac{m\,m_1}{l^2}$, where (K) is a numerical coefficient that depends upon the selection of units. Bringing forward the concrete magnitudes, we have:

(2) $\frac{[F]}{[F\,o]} = (K)\,\frac{[M]}{[M\,o]}\,\frac{[M_1]}{[M\,o]}\,\frac{[L\,o]^2}{[L]^2}$.

As such an equation between concrete magnitudes contains only the ratios of magnitudes of the same nature, it is necessarily homogeneous with respect to each kind of magnitude in particular.

There is no sense in any equation between concrete magnitudes that does not satisfy this condition.

3. CHANGE OF UNITS.

Let us suppose we wish to adopt new units, [F'o], [M'o], [L'o], determinate by their measurements F, M, L, as a function of the old ones. We shall have:

(3) $F = \frac{[F'o]}{[F\,o]}\quad M = \frac{[M'o]}{[M\,o]}\quad L = \frac{[L'o]}{[L]}$, and the magnitudes [F], [M], [L] will have for measurement in the new system

(4) $f' = \frac{[F]}{[F'o]}\quad m' = \frac{[M]}{[M'o]}\quad m'_1 = \frac{[M_1]}{[M'o]}\quad l' = \frac{[L]}{[L'o]}$

whence

(5) $f' = \frac{1}{F}f\quad m' = \frac{1}{M}m\quad m_1 = \frac{1}{M}m_1\quad l = \frac{1}{L}l$.

It will be seen that *if we multiply the unit of length* [L o], *for example, by a coefficient* L, *all the measures of length will be multiplied by* $\frac{1}{L}$.

Newton's law will be expressed in the new system by the formula

(6) $f' = K'\,\frac{m'\,m'\,1}{l'_2}$, or

(7) $\frac{[F]}{[F'o]} = (K')\,\frac{[M]}{[M'o]}\,\frac{[M_1]}{[M'o]}\,\frac{[L'o]^2}{[L]^2}$.

Equations (1), (4), and (6) give the relation:

(8) $(K') = \frac{F\,L^2}{m^2}\,(K)$, or, again,

(9) $F = \frac{(K')}{K}\,\frac{m^2}{L^2}$.

If we make no hypothesis as to the value of K', the three units [F'o], [M'o], [L'o] will be arbitrary; but, as a general thing, the value of K' will be given *a priori*. There will then be but two arbitrary units, the third being deduced from the others.

Two prominent cases present themselves: We may propose not to modify the coefficient (K) of the original equation by a change of units; then K' = K.

We may select the new units in such a way that the numerical coefficient shall take the value m. In this case K' = 1.

(*a.*) *Equations of Dimensions.*—Let us suppose we wish to make K = K'. Equation (9) gives

(10) $F = \frac{m^2}{L^2} = M^2\,L^{-2}$.

Let us remark that this relation is deduced immediately from the original equation by putting

$$m = m' \text{ and } K = 1.$$

It shows that if we consider the units of length and mass as arbitrary, and multiply the primitive units [M o] and [F o] respectively by M and L, we shall have to multiply the corresponding unit of force [F o] by $\frac{M^2}{L^2}$ or $M^2\,L^{-2}$ in order that the law of Newton shall remain identical with itself when we pass from the first system to the second. We shall say that the unit of force is

* In *La Lumiere Electrique.*

FIG. 1.—CONTINUOUS ELECTRIC TRAIN.

of dimensions 2 with respect to the unit of mass, and of dimensions −2 with respect to the unit of length.

Equation (8) is an *equation of dimensions.*

If we take for arbitrary units those of length and mass, the measure of a force [F], in passing from one system to the other, will be multiplied by the inverse of $\frac{M^2}{L^2}$.

(*b.*) *Equations of Condition.*—Suppose now that we propose to have

$$K' = 1.$$

Equation (7) gives

$$(11)\quad F = (K)\frac{M^2}{L^2}.$$

It was in equation (1) that we made $m = m'$.

Always admitting that the units of mass and length are arbitrary, equation (9) will determine the value of the unit of force that will eliminate the numerical coefficient K from Newton's law. It is an equation of condition.

(*c.*) *Absolute and Variable Coefficients.*—There is reason for making a distinction between the numerical coefficients that may appear in formulas. Those that might be called variable coefficients depend only upon the relative magnitude of the units, and have no proper value. Others, such as π, for example, represent the ratios of two magnitudes of the same nature, and are consequently independent of the selection of units. These are absolute coefficients.

The usual densities enter into this case, for the relative density of a body is nothing but the ratio of its absolute density to that of water. It is independent of the selection of units.

4. SELECTION OF UNITS.

In the selection of units we should be guided by the following considerations: It is necessary, in the first place, that we shall be able to reproduce their relations at any moment, without being obliged to refer to arbitrary standards that are capable of being destroyed, or even altered by time. It is necessary, then, that the *definition of a unit* shall be independent of its dimensions and of the nature of the standards that represent it. Thus, the electromotive force of a given pile would be a bad unit.

A second condition that units should fulfill is that of causing the disappearance of variable coefficients from mathematical formulas and physical laws. If we take absolutely arbitrary units of length, force, mass, and velocity, the theorem of the live forces will no longer be explained by the equation

$$\sum \frac{1}{2} m v^2 - \sum \frac{1}{2} m v_0^2 = \Sigma \mathfrak{F} r. F$$

It will be necessary to introduce a numerical coefficient, K, so that

$$\sum \frac{1}{2} m v^2 - \sum \frac{1}{2} m v_0^2 = K \Sigma \mathfrak{F} r. F$$

And the same quantity of energy, considered under two different forms, would no longer be represented by the same number.

A system of units fulfilling the first of the conditions that we have named is a *rational* system; but in order that a system of units may be considered as *absolute*, it is necessary also that it shall satisfy the last condition.

5. ABSOLUTE UNITS.

In order to pass from any system of units to an absolute one, it is necessary to consider the equations of condition, which eliminate the variable coefficients from mathematical and physical formulas. These equations, as has been seen, are merely the laws themselves expressed as a function of the units that have been arbitrarily selected, in considering the different mathematical and physical magnitudes that figure therein as unknown. The values of these magnitudes, determined by the complete system of the equations of condition, represent the absolute units expressed as a function of the old ones.

Two equations of condition, when they are correct, cannot be incompatible; for such equations represent mathematical or physical laws that cannot lead to contradictory results. The number of distinct equations is therefore less than or equal to the number of the unknown ones. If the number of the latter exceeds, by n, that of the distinct ones, there are n arbitrary units, and consequently an infinity of absolute systems. If the number of the unknown is equal to that of the equations, there are no arbitrary units. The known equations of condition leave one arbitrary unit.

II.

THE C. G. S. SYSTEM.

1. HISTORY.

Gauss was the first to use mechanical units for units of magnetic magnitude; but the true creator of the electrostatic and electromagnetic systems was Mr. W. Weber (1881).

In 1861, the British Association for the Advancement of Science appointed a committee for the purpose of determining what would be the best unit of resistance, and for constructing a standard therefrom. This committee proposed as a unit what was later on called the *ohm*, but it had no time to construct standards.

In 1862, a second committee was appointed for the purpose of continuing the labors of its predecessor. It consisted of Messrs. Wheatstone, Williamson, Thomson, Stewart, Siemens, Matthiessen, Maxwell, Miller, Joule, Jenkin, and Bright. It did not believe that it ought to confine its researches to the special programme that had been laid out for it, but rightly thought that a selection of a unit of resistance could not be made independently of a selection of other units, and so proposed to create a complete system of scientific units. It took up the labors of Weber in order to co-ordinate and complete them, re-established the electrostatic and electromagnetic systems, and, for practical units of electromotive force and resistance, adopted the *volt* and the *ohm* (1863).

In practice, the name of Weber, who originally designated the unit of quantity, was applied to the unit of intensity; but it was applied in different senses, and as many as four distinct significations were given to it.

The International Congress, which met at Paris in 1881, ratified the labor of the British Association. It gave to the system of units devised by it the name of "C. G. S. system," from the three initial letters of the three fundamental units. It preserved the *ohm* and the *volt*, and completed the practical units by adopting the *ampere* as unit of intensity, the *coulomb* as unit of quantity, and the *farad* as unit of capacity.

As a distinction from arbitrary units the C. G. S. units have received the name of *absolute*. We have seen that this denomination is improper.

2. FUNDAMENTAL UNITS.

In the C. G. S. system there have been adopted three arbitrary fundamental units, whose initials have given the system its name.

The unit of length..............centimeter
" " mass...............gramme-masse.
" " time...............second.

The centimeter is the hundredth part of the unit of length preserved in the archives, representing approximately the forty-millionth part of the terrestrial meridian.

The gramme-masse is the mass of a cube of water at a temperature of 4° C. The weight of this mass, weighed in a vacuum, is one gramme at Paris.

3. DERIVED UNITS.

All the derived units are deduced from the three fundamental ones by means of a mathematical, mechanical, or physical equation in which figure, on the one hand, the magnitude whose unit is to be determined, and, on the other, magnitudes whose units have already been determined.

In order to avoid the variable coefficient in the equation chosen, we adopt, for the unit sought, the value of the magnitude considered, which is determined by this equation, when all the other magnitudes take their unit value. Thus, supposing we know the units of electromotive force, F, and intensity, I, we shall be able to determine the intensity of resistance by Ohm's law.

$$R = \frac{E}{I}$$

This will be the resistance in which the unit of electromotive force produces the unit of intensity.

In the C. G. S. system, what we call the *dimensions* of a derived unit are its dimensions with respect to the fundamental units L, M, T.

4. GEOMETRICAL UNITS.

Surface.—The surface of a rectangle is proportional to the product of its sides. The C. G. S. unit of surface is the *square centimeter*. The equation of dimensions of surface is $S = L^2$.

Bulk.—The unit of bulk is the *cubic centimeter:* Dimensions, vol. $= S\,L = L^3$.

Angle.—The intercepted arc, l, is proportional to the angle ω and the radius r.

(1) $l = (K)\,\omega\,r$.

In order to eliminate the parasitic coefficient (K), it would be necessary to take for unit of angle one whose arc is equal to the radius.

This angle, for which Mr. Everett has proposed the name *radiant*, expressed in ordinary degrees, would have an incommensurable value that would be, approximately,

$$\frac{180}{\pi} = 57{\cdot}19 \text{ or } 57°\ 11'\ 2{\cdot}4'',$$

so it is preferred to keep the arbitrary unit of angle, which is the *degree*. Consequently, equation (1) preserves a parasitic coefficient

$$K = \frac{\pi}{180} = 0{\cdot}017485:$$

$$\text{Dimensions, } \Omega = \frac{L}{L} = 1.$$

5. MECHANICAL UNITS.

Velocity.—The unit of velocity is one centimeter to the second: Dimensions, $V = L\,T^{-1}$.

Acceleration.—The unit of acceleration is likewise one centimeter to the second: $A = L\,T^{-2}$.

Force.—To define the unit of force, we make use of the principle discovered by Galileo that the forces, F, are proportional to the masses, M, and to the accelerations, A, that they give them: $F = M\,A$. We take, then, for unit of force that which would give the unit of mass (the gramme-masse) the unit of acceleration (one centimeter to the second). It is the *dyne:* Dimensions, $F = M\,L\,T^{-2}$.

Energy.—The unit of energy, the *erg*, is the work produced by the unit of force shifting its point of application from the unit of length according to its own direction: Dimensions, $W = M\,L^2\,T^{-2}$.

6. ELECTRIC UNITS—THE ELECTROSTATIC SYSTEM—ELECTRODYNAMIC UNITS.

The committee of the British Association considered that, among electric magnitudes, there were four that were capable of measurement, viz.: Intensity, I; electromotive force, E; resistance, R; and quantity, Q.

The relations of these magnitudes to each other are two in number, viz., the law of Ohm,

$$(1)\qquad I = \frac{E}{R}$$

and a law verified experimentally by Faraday, according to which the static quantity of electricity carried along by any current is proportional to the intensity of the latter and to the time, T, during which it circulates. This law is expressed by the committee as follows:

$$(2)\qquad Q = I\,T.$$

Certain laws connect these electric magnitudes with mechanical ones. Such is Joule's law: The work, W, effected by a current of intensity, I, circulating in a resistance, R, during a time, T, is proportional to the square of the intensity, to the resistance, and the time. The committee writes this law thus:

$$(3)\qquad W = I^2\,R\,T.$$

We have thus three equations for four unknown quantities. A fourth equation is therefore necessary. We may take Coulomb's law:

$$(4)\qquad F = \frac{Q^2}{L^2}.$$

Equation (4) determines the unit of *quantity.* It is the quantity that exerts an action equal to the unit of force upon an equal quantity placed at the unit of distance: Dimensions, $Q = M^{\frac{1}{2}}\,L^{\frac{3}{2}}\,T^{-1}$.

Equation (2) determines the unity of *intensity:* Dimensions, $I = M^{\frac{1}{2}}\,L^{\frac{3}{2}}\,T^{-1}$.

Equation (3) gives the unit of *resistance:* Dimensions, $R = L^{-1}\,T$.

Equation (1) gives the unit of electromotive force: Dimensions, $E = M^{\frac{1}{2}}\,L^{\frac{1}{2}}\,T^{-1}$.

These four units, as well as all those that may be deduced from them, will form the *electrostatic system.*

Instead of equation (4), we might have taken one that expresses the action, F, of a conductor, of a length L′, bent into an arc of a circle of a radius L, and traversed by a current I, upon a pole, P, placed in the center:

$$(5)\qquad F = \frac{P.\ I.\ L'}{L^2}$$

the pole unit being determined by the equation

$$(6)\qquad F = \frac{P^2}{L^2}$$

which gives

$$P = M^{\frac{1}{2}}\,L^{\frac{3}{2}}\,T^{-1}.$$

Equation (5) then determines the unit of intensity: Dimensions, $1 = M^{\frac{1}{2}}\,L^{\frac{1}{2}}\,T^{-1}$.

Equation (2) gives

$$Q = M^{\frac{1}{2}}\,L^{\frac{1}{2}}.$$

Equation (3) gives

$$R = L\,T^{-1}.$$

Equation (1) gives

$$E = M^{\frac{1}{2}}\,L^{\frac{3}{2}}\,T^{-2}.$$

These five units, as well as all those that can be deduced from them, will form the *electromagnetic system.*

The electromagnetic units are different from the electrostatic ones. This is due to the fact that the two systems of fundamental equations 1, 2, 3, 4 and 1, 2, 3, 5, 6, are incompatible.

We have stated above that correct equations of condition cannot be incompatible. Among the fundamental equations there must be, then, at least one that is erroneous.

There are simple ratios existing between electrostatic and electromagnetic units, as well as between their dimensions. We obtain the *dimensions* of an electromagnetic unit by multiplying those of an electrostatic unit by $[LT^{-1}]^{\alpha}$, where α is a positive or negative exponent that varies from one unit to another.

Upon multiplying an electrostatic unit by v^{α}, we shall have the *magnitude* of the corresponding electromagnetic unit; α is the same as before, and v is a number that approximately represents the velocity of light and electricity, which is about 300,000 kilometers per second.

We apply the name of *electrodynamic* to a unit of intensity proposed by Ampere, but which has never been employed. Ampere's law is thus expressed:

$$(1)\ f = h\,\frac{ii'\,ds\,ds'}{r^2}\left(\cos\varepsilon - \tfrac{3}{2}\cos\vartheta\cos\vartheta'\right).$$

Ampere takes the value one for the variable coefficient h. Formula (1) is then reduced to $f = \frac{ii'\,ds\,ds'}{r^2}\left(\cos\varepsilon - \tfrac{3}{2}\cos\vartheta\cos\vartheta'\right)$

If we consider two parallel elements, at right angles with the straight line that connects them, we have:

$$(2)\qquad f = \frac{ii'\,ds\,ds'}{r^2}$$

The action of an indefinite current, i, upon a parallel current of an intensity i' and length l, placed at the distance d, and deduced from the general formula, is

$$f = \frac{ii'\,l}{d}$$

We may therefore define electrodynamic intensity as being the *intensity of a rectilinear current which, with the unit of force, would be attracted by an indefinite parallel current of the same intensity situated at a distance equal to its own length.*

The unit of electrodynamic intensity, j, is equal to the unit of electromagnetic intensity, i, divided by $\sqrt{2}$

$$j = \frac{i}{\sqrt{2}}$$

7. CRITICISM OF THE C. G. S. SYSTEM.

As we have already said, the fundamental units of the C. G. S. system are the centimeter, the gramme (masse), and the second.

In adopting a decimal fraction of a quarter of the terrestrial meridian passing through Paris as the unit of length, it was proposed to take as a unit an invariable length in nature. We know now that the meter is too short by $\frac{12}{100}$ of a millimeter. It therefore does not answer to its definition, and, what is worse, it is permissible to doubt the invariability of the earth's dimensions. The gramme-masse, founded upon the meter, is open to the same objection. As for the second, that cannot be fixed, as the length of the day is variable.

The unit of force has been deduced from the units of length, mass, and time, in starting from the principle of Galileo as to the proportionality of forces to masses and accelerations.

$$(1)\qquad F = MA = MLT^{-2}.$$

But there exists another relation between forces, lengths, and masses; it is the Newtonian law of attraction.

$$(2)\qquad F = (f)\frac{M^2}{L^2}$$

In the C. G. S. system, this law contains a variable coefficient (f) that it is desirable to get rid of. There will then be but two arbitrary units out of three, for equations (1) and (2) give, between the units of mass, length, and time, the equation of condition.

$$(3)\qquad (f)\,M = \frac{L^3}{T^2} = L^3\,T^{-2}$$

We can give a physical interpretation of this law. Suppose, for greater simplicity, we have got rid of the variable coefficient (f); then equations (1) and (2) will take the form

$$(2\ bis)\qquad F = \frac{M_2}{L_2}$$

$$(3\ bis)\qquad M = \frac{L^3}{T^2}$$

Let us consider a satellite, m, gravitating around a star, M, and let r be the common distance. The centrifugal force that balances the attraction, $\frac{Mm}{r^2}$, of the star, M, will be

$$F = \frac{m\,v^2}{r} = \frac{M\,m}{r^2}$$

where v represents the velocity of the satellite in its orbit; whence

$$M = v^2\,r.$$

Let us suppose the satellite to have a constant velocity, and to describe a circle around M as the center. The space, l, passed over at the end of the time, t, will be

$$l = v\,t$$

whence

$$M = \frac{l^2\,r}{t^2}$$

If we take the units of length and time arbitrarily, we may define the unit of mass as the *mass around which a satellite, placed at the unit of distance, would traverse the unit of length during the unit of time.* Let us remark, by the way, that for one entire revolution

$$l = 2\,\pi\,r$$

$$t = T,$$

T being the time of one revolution, and

$$M = \frac{4\,\pi^2\,r^3}{T^2}$$

If M represents the mass of the sun, $\frac{M}{4\pi^2}$ will be the constant of the third law of Kepler, the expression of which, in absolute units, would be

$$\frac{r^3}{T^2} = \left(\frac{M}{4\,\pi^2}\right)$$

In the electrostatic system, we adopt as fundamental equation

$$(4) \qquad F = \frac{Q^2}{L^2}$$

According to a law pointed out by Maxwell, and experimentally verified by Prof. Rowland, two quantities of static electricity, Q, of the same sign, forced to remain a constant distance from each other, and having a common velocity, V, will exert a mutual attraction proportionate to the product of the masses, as well as to the square of the common velocity, and inversely proportional to the square of the distance:

$$F = (\alpha)\,\frac{Q^2\,V^2}{L^2}$$

This attraction exactly balances the static repulsion (4) when the common velocity, V, is the velocity, v, of the propagation of electricity; whence

$$(\alpha)\,\frac{Q_2\,v^2}{L^2} = \frac{Q^2}{L^2}$$

and

$$\alpha\,v^2 = 1$$

In order to eliminate the variable coefficient α, it is necessary to adopt the velocity of electricity as the unit of velocity. There then remains but one arbitrary fundamental unit, and equation (4) will have to be replaced by the general equation

$$(5) \qquad \frac{Q_2\,V^2}{L^2} = F$$

V being here supposed to be constant and equal to the velocity of electricity.

IMPROVED FILTERING FUNNELS.

By B. NICKELS, F.C.S.

THE usual devices for accelerating filtration are well known to chemists, but they all have the disadvantage of leaving certain parts of the filter paper without any support at the back, causing thereby a grave risk of breakage of the paper. Fig. 1 represents a double

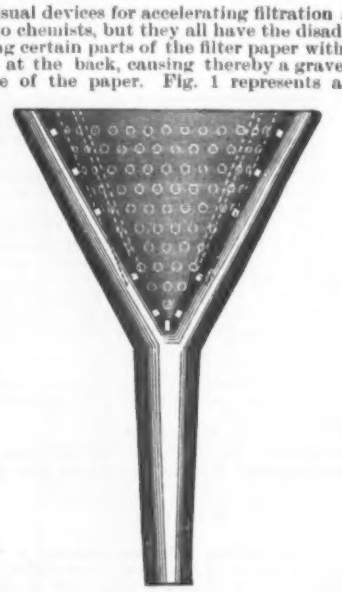


FIG. 1.

funnel, the inner attached to the outer by means of suitable "ribs" or "projections" placed at intervals. The inner funnel is perforated with holes in a downward direction. Fig. 2 is similar to Fig. 1, with the exception that the space between the two funnels at the top is closed, with a stopcock for admission of air and for cleaning purposes. Ordinary filtration with these funnels is greatly quickened, as the filtrate has a free exit through all the perforations. It is frequently desirable to wash the back of a filter paper; but this is risky, and always unsatisfactory. With the improved filter, however, it is only necessary to attach a piece of tube, with a stopcock, to the bottom of the funnel, and when the filtrate has drained away, to close the cock and fill the jacket with the water or other wash liquor, which immediately makes its way through the holes to the *back* of the filter paper, quickly and thoroughly washing the same.

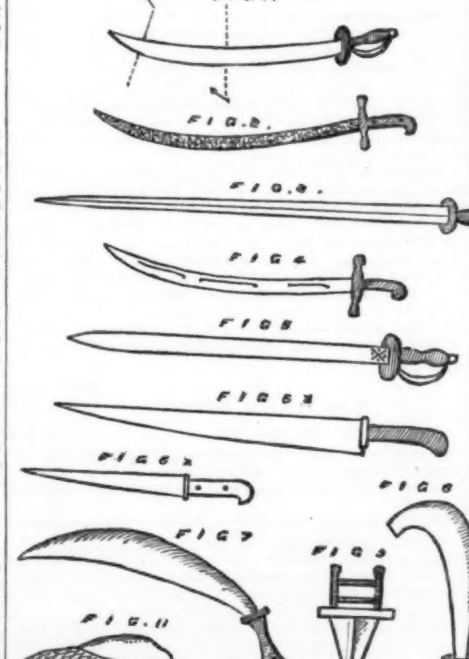
Fig. 2 is for use in connection with aspirator, water or other pump. The usual hollow platinum cone is unnecessary; the perforations in the inner funnel, being very small but numerous, admit of a high vacuum being employed without risk of breaking the paper, and filtration is conducted with very great rapidity. Dialyzing, as usually conducted, is troublesome, owing to the difficulty of making a tight joint with the parchment paper to the proof containing the liquid to be dialyzed. All that is necessary with this funnel is to

FIG. 2.

attach a tube and stopcock to the end, and place a piece of parchment paper folded as a filter paper in the inner funnel, but projecting about one inch above the top. The liquid to be dialyzed is place therein, and the jacket filled with distilled water, which may be drawn off as it becomes charged with the products of diffusion, and replaced by a fresh supply. The quantity of water is thus minimized, which is an important feature in this operation. The funnel is well adapted for filtration of volatile liquids, and may supersede the somewhat complicated apparatus usually employed. The funnel is placed through a cork, and tightly inserted into a vessel to receive the filtrate. The filter paper having been inserted in the usual manner, the liquid to be filtered is poured therein in the ordinary way, and the *whole top of the funnel* covered with a disk of ground glass, underneath which may be placed a disk of India-rubber, if the joint is not tight enough. As the filtrate enters the vessel, the displaced air finds its way to the top of the funnel jacket, and entering the inner funnel through the holes, causes filtration to proceed without cessation or loss of volatile liquid filtrate.—*Jour. S. Chem. In.*

EASTERN SWORDS AND DAGGERS.

THE high class damascened and exquisitely tempered blades, the curved cimeters of extra hard steel, and the keen weapons of highly finished durability, came to India with those mighty conquerors of the East, the Mohammedans, whose descendants under the victorious and peace-promoting British rule can no longer follow the craft, disarming being the prevailing *régime.* The comparatively few sword blades of sterling quality nowadays are only to be found in the palaces of loyal princes, most of them heirlooms in their armories. Before the great mutiny, every native, even menial servants, carried a sword; the peasant at his plow wore the weapon of defense; so did the homeless wanderer in search of employ, and the black soldier on short leave. It was a national appendage, due to the unsettled state of popular feelings and lawless inclinations. The excited Moslem printed and shouted the great text of the False Prophet, "The sword is the key of heaven and hell;" while the quiet Hindoo frequented midnight meetings, and brought his *teghar*, or village saber, to a razor edge. The quiet dweller in England will scarcely believe the prodigies performed in sword cutting by these coarse, ill-looking bits of curved metal, costing frequently no more than 1s. 6d. to 2s.! The Englishman can excel in everything if he chooses to master the object. Not less than half a dozen, perhaps even a dozen, have attained such swordsmanship with the Oriental weapon as to be acknowledged champions, the title of "Master of the Sword" (Sahib Tulwar) being bestowed on them by universal consent. I had shot numerous wild beasts, when I was told by an expert that my hunting education was very deficient, as I could not handle a cimeter to stop my game. I was told to exercise continually on a pillar of soft clay, and thus acquire the drawing cut at the proper part of the blade; then on a pillar loosely stuffed with cotton; then on a newly killed wildcat or jackal, kneaded previous to the practice by the feet of a heavy man till the carcass became a loose, soft mass; then on a great pond carp, a fish clad with heavy, horny scales, like elastic mail—considered an A1 feat to test man and sword. My first trial at this experiment resulted in a triple fracture of the good blade, sundry scales flying in the air, uncut, only dislodged; then the artistic *tour de force* at paper cones placed on a table, and muslin thrown up to a height—all manner of strange and difficult tasks, which, being only ornamental, I eventually forsook for the useful and more easy decapitation of fierce quadrupeds, beginning with a wounded wild hog of full growth, and on essaying the sloping stroke behind the ear, sweeping off the head nearly, that important part dropping between the fore feet. Not long before I had seen a bold young Ghoorka princeling dismount from his elephant, leave it standing to await his return, and follow on foot alone an immense boar he had wounded with his rifle. On nearing the powerful brute, it champed its foamy tusks to charge. He drew his *kookree* (or Nepaulese sword), and as it sprang at him, the blade was buried across piggy's back, all but severing him in two parts! Perhaps the readers of "E. M." will not credit my statement of village peasants with sword and shield attacking and slashing a full-grown tiger, when one of these powerful animals has strayed from the forest into their fields. Yet I have often known such encounters—a man or two always killed and several wounded, the tiger's skin spoiled, too, by the long, deep cuts of their teghars. I saw a champion swordsman, a native soldier, who went into the rose bushes alone with no other weapon—shield on shoulder. His cuts were masterly; but the bold man was soon struck down and severely mauled. A crowd came to the rescue and shot the beast; the hero slowly recovered. "The Manly Weapon" is its designation. In their party fights each side would swear that no other deadly arm should be used. I accidentally witnessed one of these combats. Swordsmen, shield on arm, in twos and threes, came running to the scene of quarrel—a cow's trespass. It was an exciting event. Clansmen were continually arriving, and every man selected his foe. There was grand sword play. The head, legs, and arms seemed to me the chief points of attack. Being a British subject, passing through an independent state, I was obliged to gallop off as fast as my horse could go at the commencement of this battle. At the same time and place near my camp two brothers fought a duel about land; one was killed, the other well slashed. In two or three days I passed by a battle royal. The King of Oudh's troops were besieging some refractory land owners, who refused to pay their rents. Heavy cannon were booming around, and musketry cracking; the village swordsmen and feudal retainers, under cover of night, made many a daring sally, and left the print of their teghars on Moslem limbs. I saw blood-stained bodies on rude cots being carried away to their homes. The unequal struggle had already lasted three days. That tough and stubborn peasantry could boast that in long years they had never once been defeated—no, not even by regular troops! Among some military trophies, I once saw a very rude, rusty teghar—*locally worth a shilling*—which had cleanly decapitated a raw recruit, severing coat, collar, brass buckle, and caste necklet of hard enamel beads. The nimble village rebel had sprung on the Sepoy from a bush while trimming his flintlock after a misfire. This and all the low-priced teghars and tulwars are of very soft metal, capable of being bent and straightened across the blade, while the arch, or cutting portion, with razor edge, offers immense resistance in the hands of an expert, who, behind his shield, can watch and measure his opportunity; only the straight thrust of British bayonets or dragoon blades can reach him. The metal and finish of cutting arms improve when we enter North India. Hard steel of fine temper and high workmanship used to be common until two Sikh wars and the great mutiny abolished the demand for such deadly wares. The skillful Mohammedan craftsman had to emigrate for a livelihood, or too often dwindled into a blacksmith of harmless occupation. I remember in the good old times of the East India Company itinerant sword peddlers. Persians and Afghans, of great stature and big turbans.



EASTERN SWORDS AND DAGGERS.

"Do you want any swords?" "Yes; but where are they?" "Here," and the vender's hands were lifted to his head cloth, where they groped awhile; out sprang three or four shining steel snakes, elastic blades, unhandled *a la mode*, £20 to £50 each in value, sometimes more. Then the dealer put them through various severe tests to satisfy his customer, packing them away again in their hiding place, should there be no sale, and going on his road. But there were many shapes and sizes and sorts of cimeters of great price, harder and less flexible, both plain and damascened.

The black steel of Khorasan, very rare in the market, reputed to cut off the neck of an anvil—an Eastern anvil, of course. The Persian and Central Asian specimens, elegantly watered in circular veins, some so light that a girl could use them, others so heavy that height and length of arm, with breadth of chest, were needful gifts of nature to utilize them—men like "Rob Roy," or "Mahmoud of Ghuzni," whose hands hung below their knees. The latter notable carried an awful steel mace in preference to a sword, and smashed idols and idolaters with his own arms on all occasions.

There are certain trade marks and superstitious symbols on special blades which the Asiatic of those days feared to counterfeit. The ponderous curved saber called the *Hosainee*, with very peculiar deep channels, like hieroglyphics, from hilt to point, found in the clenched hand of its slain owner after a great battle; the "Goojeratee" blade from the Deccan, stamped with signs and straight grooves, of hard steel, elastic as whalebone, the trusty companion of outlaws and brigands, and handed down from generation to generation of warriors—often the last dying relic of the Sepoy mutineer. Terrible two-handed swords, double-edged, heavy, and many feet long, requiring the limbs of a Hercules to wield them—such a human hero as the big Sikh Champion, who defied a crowd of bayonet thrusts in a small room heaped with his dead comrades, killing and wounding with his whirling blade every man of the 10th Regiment who advanced, till one of them, with more of caution than chivalry, transfixed the Champion by throwing his heavy musket and bayonet like a javelin.

There are one-handed swords, too, of lighter construction, with hand and arm guard attached; whirling the blade swiftly with the right hand, the left one carries a dagger or pistol as an auxiliary arm. There are thin, springy, long daggers for assassins, called *kungas*, easily concealed in the long, loose vestments of Orientals; the still more treacherous and secret *kuttar*, or Afghan dagger, with which Dost Mahomed as a boy paved the road to his throne. There is the abominable and ferocious tiger's paw, consisting of hooked dagger blades set in a heavy mailed gauntlet (said to have been sometimes poisoned). This cunningly contrived instrument has also figured in Indian history. There is the death-dealing knife of the Khyber Pass, too well remembered in the destruction of a British army forty odd years ago. These are worn and carried of every size and weight, some as large and heavy as a sword, with which the owner can cut a sheep in two parts for a feast, or expertly amputate the thigh of a charging horseman—he only fears the lancer.

The very peculiar national weapon of the Ghoorkas is something between a sword and a knife, made in two shapes. These brave little mountaineers can fell a tree or their enemy equally well. In war the Ghoorka soldier is very prone, after the discharge of his rifle, to shift the firearm into his left hand, carrying it as a guard to his body while he rushes amuck into the thick of the fight, spreading death and disorder with the fearful steel. He has never been vanquished except by starvation or overpowering numbers, and prefers death in war to capture. The metal and temper of these Nepaulese weapons is first class, the steel being worked entirely by charcoal. I have seen them made.

As I have stated above, the sword is the religious emblem of Mohammedanism. The higher classes of that fierce creed never objected to eat with Christians in public after a sword was laid across the dinner platform ("*Tugt push*"), the respective believers taking their places on either side of the dividing symbol. Everything except the flesh of swine was in the bill of fare, after being killed according to prescribed rule—*i. e.*, cutting the throat while repeating the creed of true Moslems.

The hands of Orientals are remarkably small in proportion to their bodies. We English are obliged to dismount their hilts and handles and replace them by larger sizes. I became the owner of the fine *Hosainee* blade I have described, and though not big-handed, was compelled to order a new fitting, as the weapon was destined to be my faithful hunting ally.

In all my long residence in the East I never could obtain any manufacturers' secrets from the followers of Mohammed; they are all jealous, cautious, and reserved in these matters toward Christians and Pagans alike; the artistic manipulation of steel remains locked in their breasts.

Fig. 1, *teghar*, or "village saber" (also called *tulwar*). Dotted lines show the portion of the blade used in making the "drawing cut" at an angle of 45° to 50°. Fig. 2, Oriental cimeter, only used by horsemen, the "long curve" enabling the warrior to reach a foe afoot or mounted. Fig. 3, double-handed sword, with double edge, so as to cut backward and forward when the bearer is surrounded. Fig. 4, Hosainee saber (my hunting sword); weight, 7 or 8 lb. Fig. 5, the rare Goojeratee blade, single-edged, and for cutting only. Fig. 6, Afghan knife, made in every size, to 10 or 12 lb. weight; very thick blade. Figs. 7, 8, forms of Ghoorka *Kookree*. Fig. 9, *Kuttar*, Afghan dagger. Fig. 10, *Kungar*, or *Grooptee* of India. Fig. 11, tiger's paw, curved razor-edged blades, four or more in number, mounted in brass sockets on brass-mailed leather gauntlet.

All scabbards are of soft wood and leather, to preserve edge of blades. EOS.

—*English Mechanic.*

DETECTION OF LEAKAGE FROM GAS MAINS.

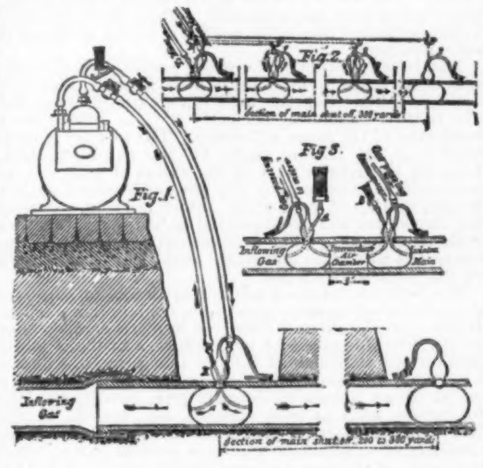
THE arrangement here illustrated, which has been devised by M. Rattier, has received considerable attention from our French contemporaries; Fig. 1 giving a general idea of its application, Fig. 2 showing it as adapted to the testing of a long length of main in sections, and Fig. 3 indicating a method of testing the appliances for soundness.

The special characteristic of M. Rattier's system is the determination of the exact extent of the leakage by means of a meter. He claims that by the use of the India rubber bags shown in the illustrations, one opening in the main suffices for plugging the pipe, taking off a certain quantity of gas, and passing it through the meter into the isolated portion of the main. Of course, the fewer holes to be pierced, the less labor will be involved. The drawings are almost self-explanatory.

In Fig. 1 the bag is shown connected with the meter by means of India rubber tubes. Care has to be taken that these tubes do not press upon the conical portion of the bag, which should be perfectly upright upon the main, otherwise there might be an escape at the neck, K. An ordinary 10 light meter is employed, placed in the position shown in the illustration.

No special method is needed for carrying out an experiment; all that is required is to completely isolate from the rest of the canalization the section of pipe which it is desired to test, and not to take the indication of the meter until the pressure of gas on the inlet and outlet is equal, as shown by the gauge, except in the case of excessive leakages, which would absorb more than the normal output of gas from the meter, and thus cause a slight resistance. The expenditure of gas caused by leakage being, as in every other case, in proportion to the pressure, this fact must be taken into account in estimating the extent of the leakage or in comparing results.

The soundness of the plugging may be tested in various ways, one of which, as already stated, is shown in Fig. 3, where an intermediate air chamber is contrived between two bags. The pressure gauge, A, being in communication with the air chamber, it is impossible for the gas to penetrate into this space without an indication thereof appearing on the gauge. Another way of testing for soundness is by blowing in air at B, when, if there is no defect in the bags, the pressure thus produced will be maintained. If, after having explored a given section of pipe, it is found that the leakage is of sufficient importance to be searched for, boring will have to be resorted to; but if the first search is fruitless, the work should not be abandoned, but the section of main again tested in shorter lengths in the manner indicated in Fig. 2. Supposing, for instance, the portion of pipe under test measures 300 yards. Two openings are made upon this length, and a bag placed in each, as shown; the two outer tubes being put in communication one with the other by a union piece provided with a tap. The gas issuing from the meter would pass freely through the first and second bags, and be arrested at the third; it would therefore fill the whole of the isolated section of main.



The first experiment would be made on the length of pipe from A to B, and would show the loss over the entire length. The second would be from C to D; the communication being broken at the second bag. The third would be from E to F; stopping off the gas at the first bag. A comparison of the results of these experiments would show in what section of the length of main under test the leakage was greatest. Then, instead of having to make openings over a distance of 300 yards, it would only be necessary to do so over 100 yards; and in thus reducing the labor by two thirds, there would be a greater possibility of success attending it. Of course, care must be taken to keep the bags in good working order. After each operation they should be cleansed of the soap with which they had been coated prior to their insertion into the main; and in the event of the India rubber becoming hard (a not unfrequent occurrence in cold weather), all that is necessary is to plunge the bags in lukewarm water to restore their elasticity.—*Jour. Gas Lighting.*

THE WELSBACH INCANDESCENT GAS LIGHT.

Complete Specification, English Patents (A. D. 1885.—No. 15,286).

Manufacture of an Illuminant Appliance for Gas and other Burners.

MY invention relates to the manufacture of an illuminant appliance in the form of a cap or hood to be rendered incandescent by gas and other burners so as to enhance their illuminating power. For this purpose I employ a compound of oxide of lanthanum and zirconium, or of these with oxide of yttrium, which substances in a finely divided condition when they are heated by a flame give out a full, large, almost pure white light, without becoming volatized or producing scale or ash, even after being kept incandescent for many hours, but remain efficient without deterioration even when they are long exposed to the air.

The proportions in which the substances are compounded may be varied within certain limits. I have found the following proportions very suitable:

60 per cent. zirconia or oxide of zirconium,
20 per cent. oxide of lanthanum,
20 per cent. oxide of yttrium.

The oxide of yttrium may be dispensed with, the composition being then—

50 per cent. zirconia,
50 per cent. oxide of lanthanum.

Instead of using the oxide of yttrium, ytterite earth, and instead of oxide of lanthanum, cerite earth containing no didymium, and but little cerium, may be employed.

For applying the substances mentioned as an illuminant I use a fine fabric, preferably of cotton previously cleansed by washing with hydrochloric acid. I saturate this fabric with an aqueous solution of nitrate or acetate of the oxides, and gently press it until it does not readily yield fluid, so that in stretching or opening out the fabric the fluid does not fill up its meshes. The fabric is then exposed to ammonia gas, and when it has been dried it is cut into strips and folded into plaits. One method of giving the desired shape to the cap or hood is to draw a fine platina wire through the meshes of the net and bend it to the form of a ring so as to give the fabric the shape of a tube, the edges of which are then sewn together with an impregnated thread. The cap or hood thus formed can be supported on cross wires in the chimney of the lamp. The platina wire ring may be attached to a somewhat stronger platina wire to form a supporting stem by which the net can be secured to a holder on the burner tube, the net itself being at such a height that the platina ring is an inch or more above the burner.

On igniting the flame, the fabric is quickly reduced to ashes, the residuum of earthy matters nevertheless retaining the form of a cap or hood.

For part of the zirconia a mixture of magnesia and zirconia may be employed with a little loss of intensity of the light.

Obviously, fabrics of various forms or constructions may be employed, according to the character of burner to which they are applied.

In order to protect the fabric and prevent its rupture when it is exposed to a strong current of gas, stronger threads can be added to the fabric before it is converted into ashes. Also the fabric can be painted with or dipped into concentrated solution of the salts so as to provide a fresh layer of the metallic salts, which becomes fully oxidized soon after the fabric has become incandescent. In order to strengthen the connection of the cone of earths to the platinum wire, those parts of the fabric which are next the wire are more fully impregnated with the solution, or with a solution of about equal parts of nitrates of magnesium and aluminum.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is—

The manufacture, substantially as herein described, of an illuminant appliance for gas and other burners, consisting of a cap or hood made of fabric impregnated with the substances mentioned and treated as set forth.

Complete Specification (A. D. 1886.—No. 3592).

Improvements in Illuminant Appliances for Burners.

In the specification No. 15,286, of 1885, of Carl Auer von Welsbach, is described the manufacture of illuminant appliance for burners, in the form of a cap or hood made by impregnating fabric with solutions of salts of certain rare metals and then by the heat of the flame consuming the fabric so that the skeleton remains, consisting mostly of the oxides of the metals, which, heated to incandescence, gives out a brilliant light. The said Carl Auer von Welsbach, continuing his researches since filing the provisional specification No. 15,286, of 1885, has found that certain substances other than those mentioned therein can be advantageously employed in producing such illuminant appliances, and has communicated the present invention, which I will proceed to describe. For making an illuminant cap or hood to produce, when heated, a white light, the following substances may be used:

1. Pure thorinum oxide makes a hood which is rigid when incandescent.

2. A mixture of thorinum oxide about three parts with two parts of magnesia makes a hood which is flexible when incandescent.

3. A mixture of thorinum oxide, zirconium oxide, and yttrium oxide, in nearly equal proportions, gives a slightly yellow tint to the white light.

4. A mixture of thorinum oxide, zirconium oxide, and lanthanum oxide, in nearly equal proportions, the lanthanum a little in excess, gives a very brilliant light, and the hood is flexible when incandescent.

5. A mixture of thorinum oxide and lanthanum oxide in equal parts, with about half a part of magnesia, makes a hood which is flexible when incandescent.

6. A mixture of thorinum oxide about three parts with one of magnesia and one of alumina gives a hood which is very flexible when incandescent.

In the mixtures which include lanthanum oxide, for a portion of that substance yttrium oxide may be substituted.

When a yellow light is desired the mixture may be—

7. Thorinum oxide and lanthanum oxide in equal proportions.

For an orange light it may be—

8. Thorinum oxide and neodymium oxide in equal proportions. As the name neodymium is new, it is necessary to explain that it is one of two metals constituting what is generally supposed to be a simple metal, didymium.

For a greenish light it may be—

9. Thorinum oxide and erbium oxide in equal proportions.

In the mixtures 7, 8, and 9, zirconium oxide may be substituted for a portion of the thorinum oxide. Though magnesia and alumina can be employed, as in 5 or 6, it is better to avoid the use of much of these substances, as hoods containing them are not so durable as those from which they are absent.

For impregnating the fabric, solutions of the salts of the metals are employed as described in the previous specification, but it is not necessary that all the substances should be in solution. Some of the salts in pulverulent amorphous or finely crystalline condition may be mixed with a solution of salts of the other metals so as to produce a thickish liquid in which the undissolved salt is suspended. With this liquid the fabric can be repeatedly soaked, surplus liquid being pressed out between the successive impregnations until there is uniform distribution of the substances over the fabric.

In preparing the solutions a number of different salts may be employed. Nitrates are generally soluble; so also, but in less degree, are the sulphates, chlorides, iodides, bromides; also some organic salts, such as acetates or formiates. Generally the fluorides, carbonates, hydroxides, and many of the organic salts are insoluble, or soluble with difficulty. Those products which are insoluble or only partially soluble may, however,

be employed as above described, in admixture with solutions of soluble salts.

When the fabric has been thoroughly impregnated and dried, and formed into the desired hood shape, it is not necessary to treat it with ammonia as described in the former specification; it may at once be subjected to the action of heat, care being taken to apply the heat first to its upper part, and then gradually downward, as may be done by lowering the burner flame within the hood or raising the hood. It is of advantage to strengthen the hood by drawing through it in various directions stronger threads, themselves impregnated with the illuminant substance, or fine platinum wires may be used. The hoods may be made as tubes, woven or knitted, some parts, especially the upper parts, being made stronger by using in these parts meshes of smaller size than the meshes generally, or by double weaving or knitting of the parts that require greater strength. Also, the hood may consist of several thicknesses of fine open fabric, or of a single fabric plaited or folded; or, instead of using fabric, a number of separate impregnated threads may be hung from a ring of platinum wire so as to surround the flame. The attachment of the hood or threads to the suspending ring should be strengthened by serving the upper part before burning with a mixture of nitrates of the metals employed and magnesium nitrate. Usually the hood is protected by being inclosed within a glass chimney like that of an Argand lamp, but when a chimney is not used it may be surrounded by a cage of fine platinum wire.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is—

In hoods prepared as illuminant appliances for burners, the use of oxide of thorium alone or in admixture with oxides of zirconium, lanthanum, yttrium, neodymium, erbium, magnesium, or aluminum, substantially as herein described.

Complete Specification (A.D. 1886.—No. 9,806).

Method of obtaining Compounds of the Rarer Metals from their Earths for Use as Incandescence Bodies for Illuminating Purposes.

This invention relates to the treatment of the earths of the rarer metals, such as minerals containing cerium, didymium, lanthanum, thorinum, and zirconium, in order to obtain therefrom solutions suitable for the production of incandescence bodies such as are described in the specifications to patents Nos. 15,286 of 1885 and 3,592 of 1886.

In treating cerite, orthite, and other similar minerals containing cerium, didymium, and lanthanum, for obtaining these in a separated condition, the minerals are in the first instance heated to a red heat, with free admission of air in those cases in which iron is contained therein in the form of protoxide, in order to oxidize the iron of the cerite compounds to a higher degree, and thus avoid various difficulties in the subsequent operations. This heating process is, however, only applicable when the percentage of cerium compounds is considerable, and when the mineral is a silicate, and not fusible in ordinary temperatures. A number of such minerals comply with these conditions. In particular may be mentioned cerite, the treatment of which will now be described by way of example.

The raw material, as extracted from the earth, is heated to a red heat in lumps about the size of a fist, with free admission of air, for about an hour.

The mineral is thereby changed in such manner that its original reddish gray color has been converted into yellow, and that it has taken up oxygen. The lumps, while hot, are plunged rapidly into water, whereby they crumble to pieces, thus greatly facilitating the following disintegrating process in which the material is crushed partly to powder and partly into small particles of about the size of hemp seed. The finer particles being separated from the coarser ones, both parts are stirred in suitable vessels together with ordinary concentrated hydrochloric acid, whereby the finer particles become decomposed under evolution of heat, while the coarser particles only become slightly heated. After some days the finer particles will be entirely decomposed, and if the proper proportion of acid has been used, this will have become entirely exhausted.

The decomposition of the coarser prrticles takes place more slowly, and is only completed in about a fortnight. It is advantageous to draw off the lye formed after a few days, to levigate the sludge with water, and to mix it with a fresh supply of concentrated hydrochloric acid until all particles susceptible of decomposition are decomposed, which can be ascertained by the fact that the original grains of cerite will have been converted into a friable skeleton mass of silicic acid. The chloride solution obtained by the above process is precipitated by means of oxalic acid, and the oxalates are washed by decantation and through a filter cloth, and after being pressed dry they are heated to a red heat in shallow iron pans, but only to such an extent that no complete conversion into the oxides is effected.

The brown oxides, containing a considerable amount of carbonic acid, should, on being treated in the cold with concentrated nitric acid, dissolve after a short time, with ebullition, into a dark red liquid. Only when obtained in the above described manner is the preparation suitable for the following separation process.

The oxides are now stirred together with water in a fire clay vessel and heated on a steam bath, nitric acid being added in small quantities until a frothing is observed to take place after every addition.

As the composition of the minerals is very variable, even when taken from one and the same locality, the quantity of nitric acid cannot be fixed in advance.

The nitrate solution formed after the addition of the nitric acid is digested with excess of the earths. If, after about ten hours' digesting, it is not converted into a very fine yellowish red or yellowish powder, but remains of a brown color, nitric acid must again be added, and this process must be continued until the precipitate shows the above mentioned color. The supernatant lye is then of an amethyst color, and the precipitate formed is insoluble even in very dilute lye.

If, in carrying out the process, so much nitric acid has been added that the yellowish white precipitate is dissolved into a yellowish liquid on the addition of a large quantity of water, then too much acid has been added, and quantities of the earthy sludge, obtained as above described, mixed with water, must be added until the precipitate obtained has the above mentioned properties.

In this precipitate will be contained the whole of the cerium of the original mineral in the form of a compound insoluble in water, while the lye will contain all the other rare earths.

The cerium precipitate obtained, after washing, is readily soluble in nitric acid when heated, and the dark red solution thus obtained is mainly cerium nitrate.

The principal constituents of the lye will be the elements of didymium (praseodymium and neodymium) and lanthanum.

For separating these from each other, the lye separated from the precipitate is evaporated and treated with nitric acid and ammonium nitrate, and is separated into its constituents by the formation of the ammonium double nitrates.

In order to perfectly separate the lanthanum by means of fractional crystallization, the crystallizing process must be repeated several times.

The colorless crystals of lanthanum ammonium nitrate are chemically pure, and form as solution one of the principal ingredients of the liquid for producing the incandescence bodies.

In treating zirconium this is reduced to about the size of peas, heated to a white heat under free admission of air, pulverized, and levigated, and is then digested for several days with concentrated pure hydrochloric acid, for the purpose of removing all traces of iron. The original brownish gray powder is by this means converted into a perfectly white powder, and many of the impurities originally contained in the zirconium crystals are dissolved. The fine zirconium powder is then washed and dried, and is mixed with double the quantity of calcined carbonate of soda, and, after being ground fine, it is subjected to a white heat for about three hours in a platinum crucible. The cakes of soda melt thus obtained are placed in cold clean water, when a fine white powder will be precipitated, while numerous bodies that are not useful for the purposes of the invention pass into the mother-liquor. The white powder is washed in water, dried, and treated with sulphuric acid under trituration until a sample heated on platinum clearly shows an excess of sulphuric acid.

The decomposition of the white powder by sulphuric acid takes place under considerable heating, and care must be taken that the acid is very gradually added (the powder remaining perfectly dry), as otherwise a scattering of the mass will ensue. The powder is then heated to the boiling point of the sulphuric acid, whereby the greater part of the excess of acid will be driven off. After cooling, the powder is mixed with a large quantity of cold water under stirring, whereby the zirconium will be dissolved as sulphate, together with other bodies. The undissolved precipitate is unconverted zirconium and silicic acid. This is separated by filtration and washed.

The before mentioned solution of zirconium sulphate is precipitated by ammonia in the cold, and is washed. If this material be now dissolved in nitric acid, so that no considerable excess of acid occurs, a brilliant white powder will after a short time be precipitated, which is a peculiar combination of zirconium, containing this metal in an almost chemically pure condition. The impurities, such as iron, alumina, etc., remain in the lye. This reaction is based on the fact that a small quantity of sulphate of ammonia present in a solution of nitrate of zirconium effects the separation of the before mentioned compound, completely so when heated, and partially when cold. As an excess of sulphate of ammonia dissolves the zirconium precipitate, this is to be avoided.

The precipitate containing the zirconium is almost quite insoluble in water, but soluble in nitric acid when freshly precipitated. When digested with ammonia it is rapidly converted into dense zirconium hydroxide, which is readily separated by washing. This body is then dissolved in concentrated nitric acid, and the solution is evaporated on a water bath, producing clear gum-like crusts consisting of zirconium nitrate.

This substance dissolved in water forms a second main constituent of the incandescence body.

The presence of small quantities of iron, such as are contained in the preparation of zirconium heretofore made, is very detrimental to the action of the incandescence body.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is—

1. The method substantially as herein described of treating cerite, orthite, and similar minerals containing cerium, didymium, and lanthanum, with hydrochloric acid in the cold, for effecting the separation of the said metals.

2. The method substantially as herein described of separating the cerium from the minerals referred to in the preceding claim, by treating the chloride solutions thereof with oxalic acid, heating the oxalates obtained to redness, and treating the resulting oxides with nitric acid, whereby the cerium is obtained in the form of a nitrate solution.

3. In combination with the method for the separation of cerium from minerals containing cerium, didymium, and lanthanum, referred to in the preceding claim, the separation of the didymium and lanthanum contained in the lye after separation of the cerium, by evaporating the lye, and treating the residue with nitric acid and ammonium nitrate, whereby ammonium double nitrates of the said metals are obtained in the form of crystals, substantially as herein described.

4. The method substantially as herein described of treating zirconium for the removal of all traces of iron therefrom, consisting in first heating the zirconium to a white heat under free admission of air, and then, after finely pulverizing the same, treating it for several days with hydrochloric acid.

5. The method substantially as herein described of producing zirconium in a form suitable for an incandescence body, by first converting the zirconium into a sulphate, and, after treating with ammonia, dissolving the same in nitric acid, thereby obtaining a precipitate which, when digested with ammonia and dissolved in nitric acid and evaporated, produces zirconium nitrate.

6. The method substantially as herein described of separating a zirconium compound from a solution of zirconium in nitric acid by means of sulphate of ammonia, whether this be present in the solution from previous processes or be subsequently added.

THE PRESENT STATE OF OUR KNOWLEDGE REGARDING LOCALIZATION IN THE CORTEX CEREBRI.*

By LANDON CARTER GRAY, M.D., Professor of Nervous and Mental Disease in the New York Polyclinic.

ALTHOUGH it has only been within a very recent time that cortical localization has been precise, the doctrine is yet an old one. The evidence of varied mental action, of which every people must have been conscious after the attainment of a certain grade of civilization, necessarily led the ancients to the conception of cerebral compartments. But these conceptions were confined to such vague ideas as those of the early Arabian physicians, who placed sensibility, intellect, judgment, and memory in the ventricles; or as those of Albertus Magnus, bishop of Ratisbon, who mapped out, on a brazen head of his own manufacture, the frontal region as the site of general sensibility and imagination, the vertex as that of intellect and judgment, the occiput as that of memory; or as those of Mondino di Luzzi, who in the fourteenth century thought each ventricle to be endowed with a particular form of intellectual force; or as Guy de Chauliac, surgeon to the Avignon popes, evolved a fanciful cerebral localization; or as Montagnanus, who in 1491 published a chart of the brain with regions indicated for the "sensus communis," for the imaginative cell, for the cogitative cell, for the memory cell, and for the rational cell; or as Ludovico Dolci, Thomas Willis, Swedenborg, Descartes, Vieussens, or Haller, who gave free rein to their imagination, unchecked by any foreshadowing of what the centuries might disclose. It was not, however, until the early part of the eighteenth century that the idea was clearly outlined. Haller and Zinn, in 1756, professed to have seen convulsive phenomena after injury of the cerebral white substance; but these observations were soon overlooked. It is too much the fashion at the present day to overlook the services which were then unconsciously rendered by Gall and Spurzheim. Both of these Germans were excellent cerebral anatomists, both have left works of unquestionable scientific merit, both were persecuted for opinion's sake,† and both lived in the thick of the times which bred Mesmer and Hahnemann, and the pseudo-scientific, semi-mystical mixture of truth and charlatanism of which Mesmer and Hahnemann were the most illustrious exponents. But Gall and Spurzheim were above the level of Mesmer and Hahnemann, as, apart from the quality of their other work, is evidenced by the fact that they counted among their believers such men as Broussais, Bouillaud, Andral, G. Comte, and, with certain qualifications, also Reil and Hufeland. Even the great Goethe thought their system of phrenology of sufficient importance to enter into an elaborate argument against it. But it is not surprising that this idle pretense of diagnosticating the mental faculties by the protuberances upon the external surface of the skull should have met with no enduring reception, or that, following the teachings of Magendie and Flourens, the medical profession should have veered to the other extreme of disbelief in any cortical localization whatsoever. It is, however, a remarkable illustration of the limitation of the human faculties that such an expert physiologist as Flourens should have failed to obtain any of the diversified and startling cortical phenomena which any tyro knows how to obtain to-day. Flourens, writing in 1824, and reiterating his assertions in 1842, stated unequivocally that removal of the brains of animals produced mental impairment in proportion to the amount of cerebral tissue removed, and not with any relation to the locality. Opposed to his teachings were the clinical observations of Bouillaud, who, in 1825, recognized that loss of the memory of words which has in later days come to be known as aphasia; of Marc Dax, who in 1836‡ located this symptom in the frontal lobe; of Broca, who in 1863 made a more precise localization within the third frontal convolution; of Andral, in 1834, who then reported cases of paralysis of the arm and leg from cortical disease; of Panizza, who in 1855 reported two autopsies which clearly indicated a relationship between sight and the parieto-occipital region of the hemisphere. It is noteworthy that, in the lively discussion of the subject of aphasia at the Parisian *Academie de Medecine* in 1864, much skepticism was expressed, and even the gifted Trousseau, in spite of his peerless clinical instinct, strenuously gainsaid that clinical and anatomical precision of Broca's which time has magnificently vindicated. Notwithstanding these clinical revolts, the influence of Flourens was paramount with such physiologists as Longet, Magendie, Matteucci, Budge, and Schiff until 1870—nearly half a century. Yet the same old vague line of thought was still germinating. In 1867 Theodor Meynert began his brilliant and original series of articles upon the structure of the cerebrum, and announced his theory of the projection system—*i. e.*, of a nerve tract which should connect with the cortex of the hemisphere all sensory surfaces and the voluntary muscular system. Through this tract all sensations should travel inward, all motor impulses should travel outward. As he puts it epigrammatically: "A cross section of the *crus cerebri* would therefore implicate the whole organism, which would simply be smelless and blind," inasmuch as the olfactory and optic nerves do not pass to the periphery through this channel. The motor portion of this projection tract went, he maintained, through the nucleus caudatus and the nucleus lenticularis, to the frontal lobe, while the sensory went, by way of the optic thalamus and the corpora quadrigemina, to the occipital and temporal lobes. The epoch-making experiments of Fritsch and Hitzig, in 1870, lent a remarkable confirmation to these teachings, at the same time that they revolutionized the existing ideas of cortical physiology. These original observers demonstrated, in direct contradiction of all previous experimenters, three important series of facts:

I. That a portion of the convexity of the cerebrum is

* Read before the Medical Society of the County of Kings, March 15, 1887.

† Gall was forbidden to lecture in Vienna, because, forsooth, it was feared that his views would disturb the minds of men in their feudal beliefs and feudal loyalty.

‡ Although he first published his views through his son, G. Dax, before the Academy, in 1863.

motor in its function, while another portion is not motor.

II. The motor portion, speaking generally, lies more anteriorly, the non-motor portion lying more posteriorly.

III. Electrical irritation of the motor portion gives rise to combined muscular contractions of the opposite side of the body.

They mapped out in the brain of the dog the centers for the neck muscles (Fig. 1), the extensors and abductors of the fore leg (+ anteriorly), the flexors and rotators of the fore leg (+ posteriorly), the muscles of the hind leg (#), and the facial muscles (⊡). They also removed with a scalpel the center of the fore leg, and found that the dog in walking set this foot down clumsily, seemingly without intention, sometimes to one side, sometimes to the other, and that this leg slid outward. In standing, the same phenomena appeared, and it was also seen that the foot was occasionally set down upon the dorsal surface. In sitting upon the hinder parts, both fore feet resting upon the ground, the affected fore leg gradually slid outward, until the animal lay prone upon the corresponding side of the body.

Fig. 1.—(After Fritsch and Hitzig.) Δ. neck muscles; + (anteriorly), extensors and abductors of fore leg; + (posteriorly), flexors and rotators of fore leg; # hind leg; ⊡ facial.

The paper of Fritsch and Hitzig gave birth to an enormous literature, to which addition is being made daily. The subject has been furiously discussed, and, in one instance, almost led to a personal altercation between two distinguished physiologists. Confirmation of the doctrine thus advanced by Fritsch and Hitzig of circumscribed cortical centers came from every side.

It was, however, soon shown that the paralysis resulting from destruction of such a center might entirely disappear, although the destruction of the center was proved by an autopsy to be complete. This seemed, at first sight, to be a serious objection to the theory; but further experimentation on the monkey tribe, as well as the results of disease in the human being, demonstrated that this recovery from the resultant paralysis of destruction of a cortical center was only observed in those animals in which the cerebrum played a subordinate part. Some lower animals, for example, run and walk soon after birth. In these, removal of the hemispheres has only a temporary effect, because in them the masses of gray matter lying beneath the hemispheres are relatively of larger development, and perform those functions which are relegated higher up in the scale of nervous evolution to the hemispheres.

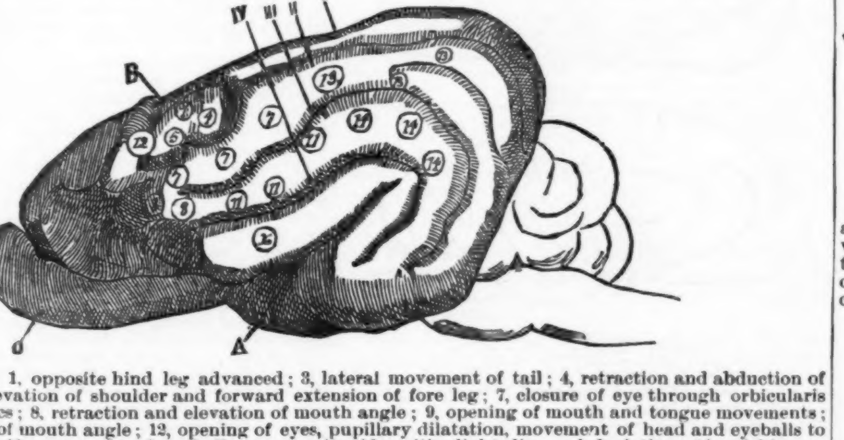


Fig. 2.—(Ferrier.) 1, opposite hind leg advanced; 3, lateral movement of tail; 4, retraction and abduction of fore leg; 5, elevation of shoulder and forward extension of fore leg; 7, closure of eye through orbicularis and zygomatics; 8, retraction and elevation of mouth angle; 9, opening of mouth and tongue movements; 11, retraction of mouth angle; 12, opening of eyes, pupillary dilatation, movement of head and eyeballs to opposite side; 13, movement of eyeballs to opposite side, with slight diagonal deviation; 14, pricking or sudden retraction of ear; 15, torsion of nostril. The figures omitted indicate centers inert in the dog, though active in monkeys, according to Ferrier.

But even those who have accepted Fritsch and Hitzig's declaration of circumscribed motor centers have not been in perfect accord with them in regard to the exact localization of each area. Ferrier, of London, has been greatly at variance with them, as will be seen by a comparison of the accompanying figure with Fig. 1. And others, while recognizing the existence of cortical centers of which electrization gives rise to muscular movements, and of which removal causes paralysis, have interpreted the phenomena differently from Fritsch and Hitzig. By one of those singular coincidences which have occurred more than once in the history of medicine—showing how public strains of thought will occasionally lead to precisely similar deductions in widely separated and differently environed individuals—Goltz in Strassburg, Munk in Berlin, Moeli in Berlin, and Tripier in Lyons, demonstrated that limbs paralyzed by removal of their cortical centers showed a loss of sensation as well as of motion. To the excitable area of the cortex, therefore, which Hitzig had regarded as purely motor, Munk gave the name of "sensory sphere" (*Fuhlssphare*). (See Fig. 3.) But Munk carried his experiments still further, and showed that lesions of the occipital lobe produced peculiar disturbances of sight. If the area, A (Fig. 3), were removed on both sides from the two hemispheres of a dog's brain, he would see things, would avoid objects placed in his path, but would be unable to recognize these things and objects. He would view with indifference his master, other dogs, his food; would not wink at the approach of a light or a finger to the eye; would not recognize the whip, at sight of which he had been taught to go into the corner.

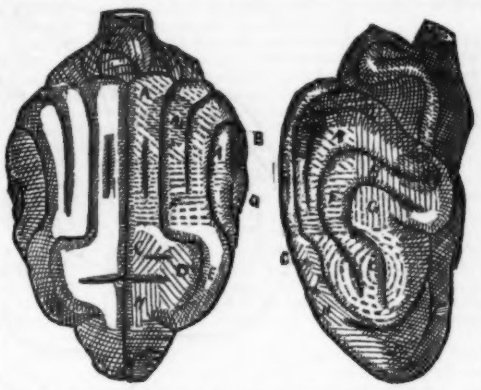


Fig. 3.—(Munk.) A, sight sphere; B, auditory sphere; C–J, sensory sphere; D, fore leg center; C, hind leg center; E, head center; F, eye center (for muscles of the eye); G, ear center (for muscles of the ear); H, center for neck muscles; J, center for trunk muscles.

But if he were permitted to take cognizance of his master, his food, etc., with the other senses, he recognized them as usual—thus, he ate food after smelling it, or retreated before the whip when it was cracked. This non-recognition of objects seen was termed by Munk "soul blindness" (*Seelenblindheit*). A better name, I think, would be "mental blindness." The removal of this same area, A, on one side produced mental blindness of the opposite eye. On the other hand, removal of the area, A, which surrounds A, caused absolute blindness; * and Munk professes to have determined that different sections of the retina are connected with different portions of this area, A.

He asserts that removal of the inner medial half of this area produces absolute blindness of the inner half of the opposite retina; that removal of the inner third of this area produces absolute blindness of about one third of the inner part of the opposite retina; that the anterior half bears the same relation to the upper half of the opposite retina, while the posterior half is connected with the opposite lower retinal half. But the most curious of all that Munk professes to have demonstrated in this connection is that the fibers from the *macula lutea*, the retinal point of most distinct sight, terminate in the area, A, so that the symptoms of mental blindness are associated with absolute blindness as regards distinct sight. Upon this anatomical peculiarity Munk bases an explanation of the mental blindness. Distinct sight, he says, through the fibers of the *macula lutea*, gives us usually our visual impressions.

When the cortical termination of these macula luteal fibers is removed, a certain time must elapse before we can become accustomed to receiving visual impressions through fibers from other parts of the retina, which, as we have seen, terminate in different parts of the area, A; and as a matter of fact, mental blindness is a symptom of short duration. It may be stated here at once, though in anticipation of what should follow, that however well this explanation may apply to dogs, it does not hold true of man, for cases have since been reported of mental blindness without accompanying impairment of distinct sight, and contrariwise, of lesion of the *macula lutea* without mental blindness. Munk also indicated the area, B, of the parietal lobe as the center of hearing, removal of it giving rise to mental deafness of the same nature as the mental blindness just described.

* This absolute blindness Munk would have us call "cortical blindness" (*Rindenblindheit*), a perfectly meaningless and pedantic term, it seems to me, that can only serve the purpose of making the confusion of cerebral nomenclature worse confounded. Munk himself has felt obliged to attach a parenthetical explanation almost every time he has used it.

The nicety of observation, the judicial tone, the care, patience, and time evidenced by each successive communication—all combined to attract great attention to the dicta of this Berlin physiologist. Nevertheless, although he soon had many followers, he did not meet with universal confirmation. Ferrier, of London, whose experiments began in 1875, following those of Fritsch and Hitzig, and supplementing these in many matters of detail, flatly contradicted Munk in regard to the sensory nature of the excitable region, as well as concerning the optic and auditory centers and their nature.

It will be readily seen that at this stage of its evolution the subject was involved in the most inextricable confusion. It became simply a matter of bias as to what a man should believe. Each physiologist maintained that there were inherent defects in the method of experimentation of the others, and each brought forward to the support of his own views facts that either had to be denied *in toto* or else accepted, to add to the doubt (compare Figs. 1, 2, 3, 4). It is not to be wondered at, then, that Goltz, of Strassburg, afterward supplemented by his pupil, Loeb, should have voiced the sentiment of many by denying altogether the doctrine of circumscribed cortical centers. He repeated especially the experiments of Munk, and stated that he obtained entirely dissimilar results. But it may be said here, once for all, that, although Professor Goltz has been extremely useful as a censor, his experiments do not warrant his conclusions; indeed, he refutes himself, so that, in similar terms to those which Shakespeare puts into the mouth of Hamlet addressing Rosenkrantz and Guildenstern, he has fretted the advocates of cortical localization, but he has not played upon them—he has not stopped their way.

But the continuance of the study upon human beings has been rewarded by more permanent conclusions. Pathology has gone hand in hand with physiology. Each has its advantages. The skull of a dog or an ape can be trephined at will, and just as much removed of the cerebrum as the operator desires; the animal can be kept constantly under observation, and often, when there are no fatal results, for a considerable length of time, and the operation can be repeated. Focal alterations of the human brain are rarely so localized, and cannot, of course, be produced at will, or kept so well under observation; so that conclusions which may rest upon a few months of physiological experiment cannot be contradicted or verified except by years of widespread and isolated observations upon the human subject.

On the other hand, human beings, with their superior intelligence, are infinitely better subjects for testing the manifold details of motion and sensation. It is therefore, I think, the better proof of the truth of the doctrine of localization that the experiments of physiologists upon the dog and monkey tribe should have tallied so well with the experiments of disease upon the human being. The individual facts of the latter kind, upon which my conclusions are based, are too numerous to be considered in a work of this kind. Any one who desires to review the testimony will find full references in the appended bibliography. It must suffice my purpose to indicate the conclusions.

Regarding the human brain, there are two sets of facts—one set that is indisputable, another that is still under discussion. Let us first consider the former.

Look at Fig. 4, in which the different convolutions are indicated. The ascending frontal and parietal convolutions are divided into three equal parts. Of these, the upper third, with the adjacent portion of the base of the first and second frontal convolutions, contains the center for the lower extremities; the middle third, with the adjacent base of the second frontal convolution, contains the center for the upper extremities; the lower third, with the third frontal convolution, contains the center for the face, neck, and speech muscles. Fig. 5 represents the medial surface of the hemispheres. The so-called "paracentral lobule" is the medial surface of

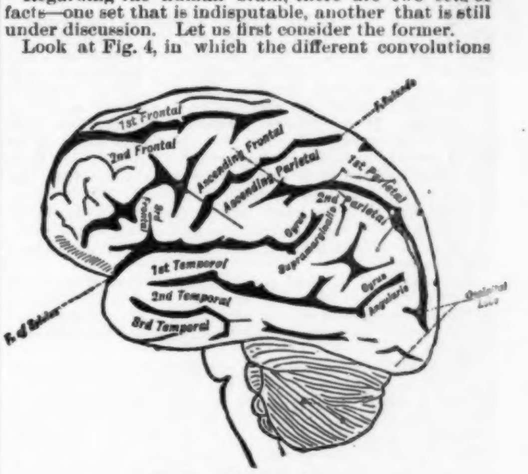


Fig. 4.—(After Ecker.)

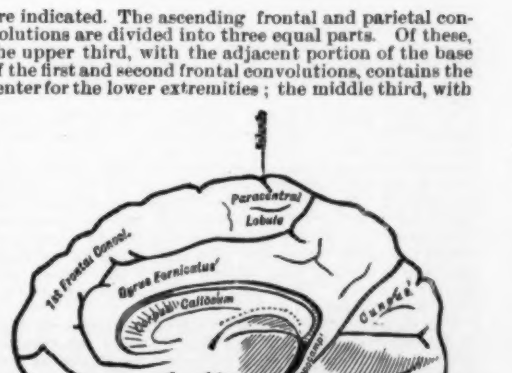


Fig. 5.—(After Ecker.)

the upper part of the ascending parietal and frontal convolutions, and therefore contains the center for the lower extremities, although lesions of this medial surface are comparatively rare. It will be perceived that this paracentral lobule is the only part of the motor convolutions that reaches to the medial surface of the hemispheres. This area upon the convex and medial surfaces is that of what may be called the "faciophonetic-skeletal region." Lesions of it produce impairment, in the manner indicated, of the upper and lower extremities, of the facial and neck muscles, and of the motor mechanism of speech. It may justly be regarded as proved that the paralysis of the limbs and the face is still motor and sensory, that the motor and sensory paralysis are not always of equal intensity, that the one may occur without the other, and that the area within which sensory paralysis may be produced is of larger extent than the motor area, inasmuch as the former embraces the two paretial convolutions (Fig. 4). It will be seen that I have mapped out these areas somewhat indefinitely.

In matters of this kind one is greatly tempted to draw precise circles for each center, and, doubtless, positivism of this kind saves much trouble to those of great faith; but I cannot reconcile facts to such a sharp delimitation. In truth, the areas overlap one another, just as the convolutions pass imperceptibly into one another, and the time will never come when a man will be able to mark a line on a convolution and say that it is a precise boundary line between two centers, so that at one hundredth part of an inch to one side there will be certain symptoms, and totally different ones at one hundredth part of an inch to the other side. The centers can only be *approximately* demarkated, not *absolutely*.

There are also good clinical reasons for believing that each different kind of sensation—the tactile, pain, temperature, and muscular senses—has a cortical center of its own; but it has as yet only been determined that the muscular sense has probably its center in the parietal convolutions.

The center of sight is to be found in the occipital lobe and the angular gyrus (Fig. 4). There has been a fierce discussion regarding this center between the followers of Munk and those of Ferrier, the former denying that the angular gyrus had any part in this center, the latter affirming that any visual impairment must implicate both angular gyrus and occipital lobe. But the experiments of Luciani and Seppilli, and the cases collected by these gentlemen, warrant the assertion that the center embraces both angular gyrus and occipital lobe, although with this distinction, that lesion of the angular gyrus alone produces mental blindness, while lesion of the occipital lobe produces absolute blindness of the same half of the two retinæ (lateral *hemiopia**). Brill has reported a case of color blindness in which the lesion was in the cuneus, the medial portion of the occipital lobe, and Seguin and Hun have reported cases of hemiopia due to disease of the cuneus and the adjacent temporal convolution. It is not yet certain whether disease of the angular gyrus causes visual symptoms by implication of the optic tract, which passes just beneath it, or whether the angular gyrus is itself a true terminal center of some fibers of the optic tract.

The center of hearing may be located in the first and second temporal convolutions (Fig. 4), although this area does not seem to be so constant a center as some others in the cortex, for the writer and Kussmaul, perhaps also Westphal, have reported cases in which a lesion was located here without the expected auditory symptoms. It is curious, however, that the left lobe seems to be mainly affected, the right side seeming to be of greatly subsidiary importance, Luciani and Seppilli stating that it is never affected alone, while the lesion is very seldom in both temporal lobes. It is curious, too, that the cases have so far always presented the symptom of mental deafness analogous to the mental blindness, as described above, and never any absolute deafness.

The cases of cortical production of loss of smell or loss of taste have been too scanty to define the centers of those two special senses, although it is probable that the olfactory center is in the hippocampal convolution (Fig. 5).

As Goltz has combated the physiological advocates of cortical localization, so has the distinguished Brown-Sequard vigorously opposed the clinical defenders of the same doctrine. But Brown-Sequard's collection of cases is opened to two fatal objections: First, his cases antedate the period of accurate knowledge of cerebral topography; secondly, he fails to take into account the fact, which had been demonstrated by the embryological researches of Flechsig, that the motor tracts do not decussate or pass over to the opposite side in all human beings, and that consequently a paralysis may be on the same side as a cerebral lesion, and yet not militate against the doctrine of localization.

Let us now consider the facts that are still under discussion.

In some cases a lesion outside of what has been deemed the center will produce the symptoms which result from lesion of the center itself; and, again, lesions of the center that are ridiculously minute will produce as marked symptoms as if the whole center were implicated. For these reasons Exner constructed the following chart (Fig. 6), in which it will be perceived that lesions at divers points of the cortex have produced the same symptoms, although there is for each function a certain area within which the lesions are mainly grouped. This area of densest grouping of lesions Exner regards as the true center.

The figures which represent the experiments on dogs and monkeys of Luciani and Seppilli tally remarkably with the pathological data collected by Exner, as will be seen by Fig. 7. What, then, is the meaning of the production of similar symptons by lesions outside of the center? I take it to be that lesions at a distance from the true center can inhibit the action of that center. These phenomena of inhibition are very familiar to us in the peripheral nervous system. All practitioners are aware of the many nervous disturbances which are removed by removal of a tight and redundant prepuce, a urethral stricture, a diseased ovary, a post-nasal catarrh, errors of ocular refraction, tumors of peripheral nerves, etc. In these instances the nerve tract to the spinal cord or the cerebrum is a comparatively long one. But in the cerebrum the commissural

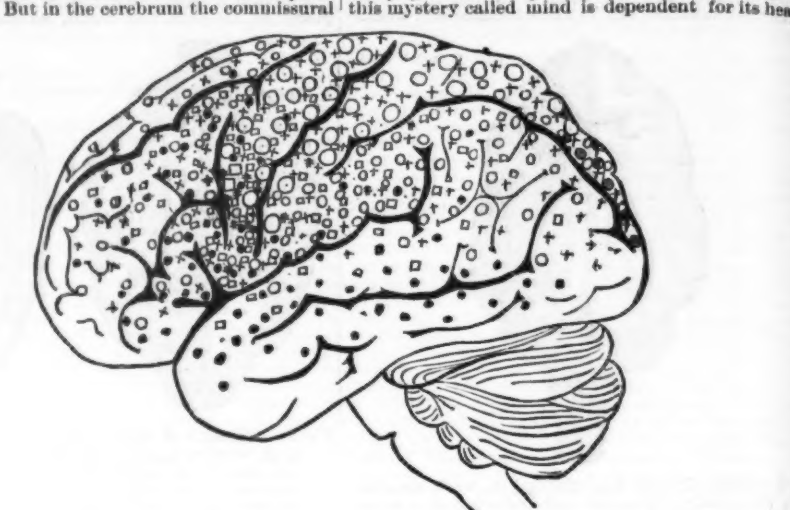


FIG. 6.—(After Exner.) o, upper extremity; +, lower extremity; ▫, facial; ⁑, hypoglossus; ●, speech; ●, sight.

tracts, connecting different areas of the cortex, are far shorter and more numerous than those leading from the nervous axes to the periphery. How much more effective, then, must be the inter-cortical inhibition. But this very probability also makes evident—what has been singularly disregarded by writers upon localization—that the locality of a lesion can only be diagnosticated with *probability*, not with *certainty*.

From this review we perceive that the doctrine of cortical localization is far too well grounded upon facts of eternal verity to be flippantly sneered at, although much remains to be done in the way that has been hewn out of primeval ignorance and acquired obstinacy. Like all truths that have lurked undiscovered for centuries, except those that do not require skilled experimentation or trained observation, it has had to

A

B

C

D

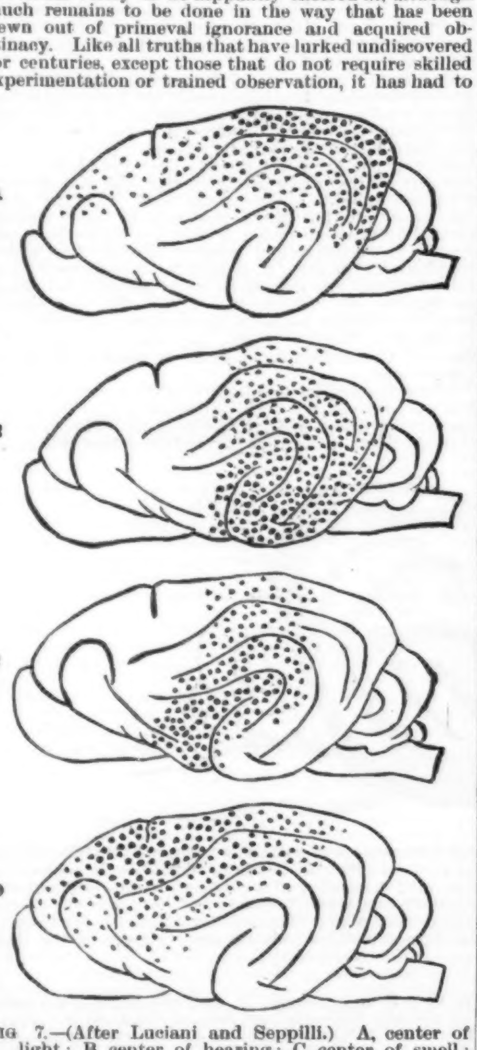


FIG 7.—(After Luciani and Seppilli.) A, center of light; B, center of hearing; C, center of smell; D, sensory sphere.

rely upon the testimony of a cloud of witnesses, each one varying in competency or bias, and the result has been the ordinary one of a long trial of issues of fact before an ordinary jury—a failure to convince every one. But the jurors of science can wait for all time, the trial is never closed, and no verdict, however conclusive it may seem at the time it is given, will stand for one hour in the face of a newly discovered fact. In spite, therefore, of uncertainties about minor points of detail, we must admit that we have localized the cortical centers for the motor and sensory nerves of the limbs and face, for the mechanism of speech, for the optic nerves, and probably also for the auditory nerves.

The question now arises, What is the meaning of these centers in the cortex? It is simply that each center is the cortical area in which certain nerve tracts terminate. Mind is, to a certain extent, a mystery, and will probably remain so, to a certain extent, for many generations, perhaps ages, yet to come. But this mystery called mind is dependent for its healthy manifestation upon the structural integrity of the cortex, and of the whole of the cortex. Hence the cortex is justly called the organ of the mind. This mind can only come into communication with the world that lies outside of the skull cap by the material highways of the nerves, some of which carry impressions into it, others of which carry actions out from it. Thus, mind sees by means of the optic nerves, hears by means of the auditory nerves, tastes by means of the gustatory, feels by the tactile, muscular, pain-bearing, and temperature-telling nerves, acts by means of the motor nerves, and educates itself by means of them all; and the so-called "centers" are simply the areas of the cortex in which these different nerve tracts terminate. These centers are the cortical stations for the great trunk lines of the peripheral nerves. It is easy to understand that there may be regions of the cortex in which there are none of these terminal nerve stations, none of these centers, and that lesions of these regions may therefore not produce any impairment of the peripheral nerves of sense and motion, but rather give rise to purely mental symptoms, disconnected with motion or sensation.

It is also easy to understand that, as has been indicated, lesions of the cortex outside of the centers should impair the action of the center itself by inhibition along commissural nerve fibers connecting one cortical area with another. Nor is it difficult to unravel the seeming complexity of certain symptom groups which have puzzled clinicians until a recent date. For example, aphasia may be both motor and sensory. When the lesion is seated in the third frontal convolution (Fig. 4), the aphasia is motor, the patient's mind is unable to act upon the muscular machinery of speech, and he cannot give expression to words. When the lesion is in the first and second temporal convolutions, the patient loses the memory of words, fails to recognize spoken words; he has the so-called "word-deafness," although he may hear perfectly well, and although he may be able to articulate words well enough. If both the third frontal convolution and the two temporal are diseased, the patient can necessarily neither articulate nor recollect words. If a lesion implicates the angular gyrus, he may fail to recognize objects that he sees, or, in some instances, the non-recognition of objects seen may be confined to words; and if the lesion extends into the occipital lobe, this non-recognition of objects seen may be complicated with blindness of one half of the retinæ (*hemiopia*). Mind itself, in all these symptons, may be intact, left isolated, as it were, in the cortex, shut off from its motor and sensory communication with the outer world.

Note.—The writer desires it to be understood that there are many facts pointing to more localization than has been indicated in the foregoing article, and some of them seemingly quite precise too. For instance, Dr. A. Fraenkel describes (Charite-Annalen, 1886) a case observed in the Charite Hospital of Berlin in which, during life, a diagnosis was made of meningitis because of the retraction of the neck, and in which there was found post mortem a softening of the base of the second frontal convolution extending into the middle third of the ascending frontal (see Fig. 4), thus confirming in a remarkable manner the localization of the center for the neck muscles made by Wernicke several years ago, after careful consideration of the experiments upon apes and monkeys (see Fig. 1, Δ, and Fig. 3, H). But again and again has experience taught us, in the seventeen years that have elapsed since the original discovery of Fritsch and Hitzig, that it is not safe to locate a center upon one or two observations. The writer has, therefore, only spoken of those localizations which he believes to have been adequately settled.—*New York Medical Journal.*

Bibliography.

Carboniere.—"Contrib. clin. all localaizzazione del centro olfattivo." "Rivista Clinica," Sept., 1885.

Charcot.—"Progres med.," 18?3.

Brill.—"Amer. Jour. of Neurology and Psychiatry," Aug., 1882.

Exner.—"Untersuch. uber den Localiz. d. Funct. i. d. Grosshirnrinde d. Menschen," 1881.

Fritsch u. Hitzig.—Du Bois-Reymond's "Archiv," 1870.

Ferrier.—"Functions of the Brain," 1886.

* Hemiopia is derived from the two Greek words "ἥμισυς, half," and "ὄπτομαι, to see," meaning therefore half sight. There is another somewhat similar word, which has led to much confusion—hemianopsia, from "ἥμισυς, half, ἀν (for ἄνα), each, and ὄψις, sight," meaning also half sight. It seems to be agreed at the present day that by arbitrary custom hemiopia shall mean the condition of the retina, while hemianopsia shall be applied to the crossing of the rays of light in the media in front of the retina. Thus, a left *hemiopia* will indicate that the left halves of both retinæ are blind, so that the patient, not being able to see objects to the right of either eye, shall be said to have a right *hemianopsia*.

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Gray.—"Jour. of Nerv. and Ment. Dis.," Sept., Oct., 1886.
Hitzig.—"Untersuch. ub. d. Gehirn.," 1874.
Goltz.—"Verrichtungen d. Gehirns," 1881
Kussmaul.—"Berlin. klin. Wochenschr.," 1885.
Loeb.—Pfluger's "Archiv," 1884.
Luciani u. Seppilli.—"Functions-Localization auf der Grosshirnrinde." Deutsch von Dr. M. O. Fraenkel, 1886.
Mauthner.—"Gehirn und Auge," 1881.
Munk.—"Ueb. d. Functionen d. Grosshirnrinde," 1881.
Nothnagel.—"Topische Diagnostik d. Gehirnkrankheiten," 1879.
Seguin.—"Jour. of Nervous and Mental Disease," January, 1886.
Starr.—"Amer. Jour. of the Med. Sciences," Jan., 1884.
Walshe.—"Colloquial Faculty for Languages," 1886.
Wernicke.—"Lehrbuch d. Gehirnkrankheiten," 1882.
Wilbrandt.—"Seelenblindheit als Herderscheinung u. ihre Bezieh. zur homonym. Hemianops., zur Alexie u. Agraphie," 1887.

RECENT ADVANCES IN PREVENTIVE MEDICINE.*

By GEORGE H. ROHE, M.D., of Baltimore, Md., Professor of Hygiene in the College of Physicians and Surgeons.

PROGRESS in any branch of science or art may be measured either by the number and character of new discoveries made or by the gradual advances in the application of knowledge previously acquired. Judged by either of these criteria the record for state medicine during the past year is a creditable one.

In the field of epidemiology and endemiology, the progressive extension of the fifth great pandemic of cholera first claims attention. Extinguished in the portions of Italy, France, and Spain ravaged in 1885 and 1886, it has slowly invaded southeastern Italy, Hungary and other Austrian possessions, and has been imported into South America, whence it threatens the United States by several routes. The danger of invasion of this country is at present greater than at any time within the past three years.

Yellow fever inoculation, as practiced by Freire in Brazil and Carmona in Mexico, has claimed a large share of the attention of sanitarians during the year. The claims made in favor of this method of preventing this scourge are now being subjected to an official investigation authorized by the United States government.

Diligent search has been made for the specific organism supposed to be the infective agent in vaccine virus, but without definite success. The results obtained are not entirely negative, however, and one may cherish the hope that a solution of this problem will soon be reached.

The relation of a peculiar disease of cows to scarlet fever, and the discovery of a specific microbe in the blood in the latter disease, have attracted much attention. The restriction of scarlet fever will doubtless be more thoroughly effected so soon as physicians are convinced of its bacterial nature, and clearly comprehend its mode of transmission. Statistics are given showing what has already been accomplished in this field.

Sternberg, Frankel, and Weichselbaum have studied the specific microbe of croupous pneumonia, which the former regards as identical with his *micrococcus Pasteuri*; in which opinion both the other authors mentioned coincide. Dr. Baker, of Michigan, has also shown that croupous pneumonia seems to be dependent upon a cold, dry atmosphere.

Measures for the restriction of pulmonary tuberculosis are adverted to. Tuberculous patients should not be treated in the same hospital wards with non-tuberculous individuals, and prompt disinfection of the sputa and other discharges should be practiced in order to diminish opportunities for infection. General sanitary measures should however not be neglected in the warfare upon the bacillus. There is danger that a too exclusive attention to the microbian factors of disease will narrow our views of epidemiology and preventive medicine.

It seems to be established that the micro-organism discovered in the intestinal lesions and discharges in typhoid fever is the cause of this disease. The fact that this microbe may preserve its vitality for a considerable time in water and ice has been shown by Bolton, Wolffhugel, Prudden, and others. This, together with the well known history of outbreaks of this disease, undoubtedly depending upon pollution of drinking water, should make prompt measures of disinfection imperative in every case. The physician fails in his duty who neglects measures for the thorough destruction of the typhoid infection existing in the intestinal discharges.

The importance of disinfection of bedding, clothing, and other personal and household articles in contagious diseases demands that health authorities should have under their control establishments where disinfection can be carried out on a large scale and at public expense. Such institutions are now in use in Berlin, Dusseldorf, Gottingen, Strassburg, Breslau, Leipzig, Danzig, and other cities in Europe. The results are pronounced to be exceedingly beneficial. Steam under pressure is regarded as the best disinfecting agent.

Quarantine, a word which for more than five centuries has been synonymous with barbarism, is becoming under modern methods a safeguard to the public against infection and an advantage instead of obstruction to commerce. The results achieved at the model quarantine station at New Orleans encourage the hope and almost warrant the prediction that the days of the quarantines of detention, whether by sea or land, are past, and that quarantine in future will mean simply *thorough disinfection* of fomites, and, of course, effective isolation of persons already infected.

Cremation of garbage seems to be the best method yet devised for the inoffensive destruction or final disposal of solid city wastes.

The irrigation system of sewage disposal has steadily won favor. In Berlin, Breslau, and Danzig in Germany, Birmingham in England, and Pullman and other places in this country it has been in successful operation. Chemical precipitation and purification of sewage has also been adopted with satisfactory results in various German cities. A board of distinguished engineers recently recommended the same system for the city of Providence, R. I.

Professor Vaughan's discovery of a very poisonous ptomaine in cheese, ice cream, and milk undergoing certain chemical changes has been confirmed by a number of investigators in various parts of the country. Vaughan's suggestion that tyrotoxicon may be found to be the poison which produces cholera infantum opens a new field for investigation in which every physician must of necessity be interested.

Analyses of food and drugs made during the year in Massachusetts and New York show the wide extent to which adulteration is practiced and how the people are defrauded. Among the most startling instances are olive oil, of which 68 samples out of 91 were spurious. Vinegar was adulterated in 79 samples out of 116; mustard 124 times in 211; white pepper 63 times in 128; black pepper 41 times in 71; mace 29 times in 45. Of nine samples of horseradish examined, only one was found genuine. A precipitate of uncrystallizable sugar and coloring matter and chloride of tin (poisonous) is sold to candy makers for making confectionery. Citrate of iron from respectable manufacturers contained 3½ per cent. of quinine instead of the 12 per cent. demanded by the pharmacopœia. Authority and means should be given to the health authorities to protect the public from these frauds, many of which are a source of danger to life and health.

Statistics collected by the speaker show that five sixths of the inhabitants of cities in this country have no facilities for bathing except such as are afforded by a pail and sponge, or an easily accessible river, lake, or other body of water. The establishment of public baths is urgently recommended, both as a sanitary as well as moral measure. Tub or pool baths are objectionable, both on account of expense and lack of privacy in the latter. The spray baths in use in the German and French army barracks are recommended. These are not expensive, either in first cost or administration, and allow each bather absolute privacy and the opportunity for a thorough cleansing in clean water. Public baths should be open the year round, and not only during the summer.

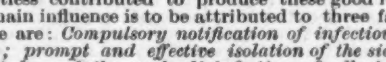
A number of instances are grouped together showing how the enforcement of appropriate sanitary measures has saved life. In Michigan the saving of life from one disease (scarlet fever) has amounted during the last eleven years to 3,718, or 338 per year. In 1886, appropriate sanitary measures saved the lives of 298 persons who would have died of diphtheria if such measures had not been enforced. In England and Wales, the average annual saving of life due to sanitary measures has amounted in the five years ending 1885 to 62,000. In Baltimore, a marked reduction of deaths from infectious diseases has followed the enforcement of certain sanitary precautions. In Memphis the death rate has been reduced in six years from 35 per thousand to 23·80 per thousand. In Chicago the reduction in mortality in the last five years has been from 25·69 per thousand to 19·46 per thousand, a net saving of 17,214 lives in that city during that period.

While all advances in sanitary administration have doubtless contributed to produce these good results, the main influence is to be attributed to three factors. These are: *Compulsory notification of infectious diseases; prompt and effective isolation of the sick and infected; and thorough disinfection of all infected articles and sources of infection.* These must be the watchwords of the practical sanitarian of the future.

* Abstract of the address in State Medicine, delivered before the American Medical Association, at the thirty-third annual meeting, held at Chicago, Ill., June 7-10, 1887.

THE CUTANEOUS PUNCH.

DR. E. L. KEYES has described an instrument which he invented, and which he calls the cutaneous punch.



¾ OF REAL SIZE.

It is about three or four inches long, with a hole in the end similar to that in an ordinary punch, and with a sharp cutting edge defining the hole. He uses it to remove the stained specks of skin in the face due to gunpowder; also for corns and other small growths. To remove the gunpowder specks, he presses the punch with a rotary motion through the entire thickness of the derma and removes each piece. His results were satisfactory. In a case of corns, he presses the punch down through the center of the growth, cutting out all the sensitive part of each corn. His results were good. A number of sizes, from $\frac{1}{16}$ inch up, are required.

THE GENESIS OF "BRIGHT'S DISEASE."

By J. MILNER FOTHERGILL, M.D., Physician to the City of London Hospital for Diseases of the Chest, Victoria Park.

THE prevalence of the morbid change so far best known by the term "Bright's disease" (from Richard Bright, who first wrote on the subject); its certain ending, sooner or later, in death; together with the fact that its course can be profoundly modified by proper and judicious measures: all combine to give the subject an intense interest for all—physician and patient alike. "Old age is not an entity, but a set of conditions predisposing to what we call chronic Bright's disease. And though to most this comes in natural course when the prime of life is run, yet to some old age is no matter of years and of averages, but the running down of a spring set for an individual." Such is the happy expression of Dr. Goodhart in his well-known Bradshawe lecture before the Royal College of Physicians of London, in August, 1885. It is a slow, gradual growth of the lowly connective tissue of the kidney at the expense of the higher kidney tissues. But the kidney mischief is only a part of the morbid change. A like growth of lowly tissue is going on in the walls of the arteries—atheroma—rendering them inelastic and brittle. But what calls out the growth of the lowly connective tissue in kidney and artery? The irritation set up by the presence of uric acid (possibly accompanied by other forms of albumen-metamorphosis) in excess in the blood. In order to grasp the matter firmly, we must look a little beyond mere clinical facts, so as to read these last aright.

We see, in the gradual evolution of life, the reptile, the cold blooded inhabitant of tropical swamps, casting out its excrementitious matter in solid form—*i. e.*, urates. The uric acid formation still continues in the warm-blooded bird, which also possesses a solid urine. When the mammalia appear, they are found to have a fluid urine, and their form of excretion is the soluble urea. But vestiges of the earlier formation still cling with the tenacity of original sin; and a certain, if small, quantity of uric acid is daily voided by man himself. So that we still carry with us traces of our descent in other forms than the branchial arches—the gills of fœtal life. Indeed, the circulation of the fœtus is that of the higher reptile; and the uric acid formation is distinctly seen in intra-uterine existence. We have long been familiar with the fact that under given circumstances the human body reverts to the early primitive form of urine stuff. As to gout, we have recognized its association with good eating, especially when accompanied by a lack of exercise.

The sensuous monk of old, lazy, fond of good living, and addicted to wine bibbing, was the typical gouty man. Now it is the country squire, whose habits were active till gout in his feet cripples him, and then its fell clutch becomes tighter and harder; or the plethoric publican, whose pleasures are those of the palate. This was the gout which came of good living. "Gout is the disease of those who will have it," said Meade. But a number of cases of distinct gout were found under widely different circumstances. They occurred in spare beings, small, fastidious feeders, whose trencher performances were conspicuous by their temperance. To this class the term "poor man's gout" was applied. It did not explain the apparent paradox, and this inability to explain it was regarded as an opprobrium to the medical profession. Doubtless a large proportion of the sufferers from poor man's gout were descendants of gouty ancestors; and only by the strictest regimen, as to meat and drink, could they elude the visitations of their hereditary foe. But the gouty ancestry was not present in all cases.

The late Dr. Budd held that sundry persons came into the world with what he called "insufficient" livers; and Dr. Murchison indorsed this view. Such livers revert to the uric acid formation very readily; and now poor man's gout stands revealed before us. Indulgence in animal food in excess reduced a normal liver to the uric acid formation.

A congenitally insufficient liver reverts to the uric acid formation under an ordinary or even meager dietary. The result is the same in each case. When the uric acid formation is established, we find one of two consequences: Either (1) the uric acid is gradually deposited in the body, in the articular cartilages by preference; or (2) is cast out by the kidneys, which, being constructed to excrete the soluble urea, are irritated by the presence of uric acid in excess; with the result of interstitial nephritis, or chronic Bright's disease. Often both are found.

Renal changes are by no means the sole morbid outcome of the uric acid formation. The cardio-vascular system feels its malign touch. A tight artery is the consequence of the blood condition, and, with that, changes in the arteries and the heart. The high blood pressure in the arterial system leads to hypertrophy of the left ventricle, and that, again, to secondary valvulitis of a progressive nature—probably due to the forcible closure of the valves; the mitral by the large ventrical; in the aortic by the recoil of the highly distended artery. Possibly in the latter there is a tendency to gouty deposits, as in the joints.

The distension of the arteries leads to a growth of connective tissue in their walls, which lose their elasticity and become brittle—the atheromatous change—and from these we get apoplexy and aneurism; while angina pectoris vaso-motoria is called out by occasional spasm of the peripheral arterioles. Sooner or later the growth of connective tissue within the coronary arteries themselves cuts down the nutrition of the large heart, and fatty degeneration spreads throughout its structure. The failing heart leads, in its turn, to dropsy, albuminuria, and death.

Indeed, we get a vast number of morbid outcomes in this widespread vaso-renal change, beyond the interstitial nephritis, which is spoken of as "chronic Bright's disease," or "renal cirrhosis," or "the gouty kidney," as it is variously termed. But the consideration here is restricted to what is truly "chronic Bright's disease," a renal change started by an impure blood, as Professor Hayles Walshe asserted in 1849.* The uric acid (and possibly other excrementitious matter of nitrogenized character, the products of albumen metamorphosis) irritates the kidney structures, and starts up a rank growth of the lowly connective tissue or packing material at the expense of the higher true structures of the kidney. Here and there in minute foci, scattered throughout its mass, mainly in the cortex at the outset, we find the destructive action at work. The lowly invader is preying upon the higher structures, like the Tartar Turk spread himself over the population of the Balkan peninsula, and with the same result—destruction. Slowly and steadily one minute portion of the kidney after another is caught within the light touch of some soft growth of connective tissue; but as the latter dries up and hardens, it contracts, and the true tissue within its clutch is ruined—squeezed out of (functional) life and (anatomical) form. Bit by bit, and often very slowly, the process goes on, until the kidneys are rendered inadequate as depurative organs, and the blood is rendered toxic by being surcharged with waste of albuminoid origin. Then follows secondary inflammation set up by the toxic blood, or other truly uræmic complications, often desperate attempts on the part of the body to cleanse its blood. To call this widespread change a "kidney disease" is as much a misnomer as to apply "Pimlico" to the whole metropolitan area; and to seek for evidence of it in the renal secretion solely is as imperfect as would be an inquiry into the sanitary arrangement of Lambeth, however carefully conducted, as to the state of the whole area which discharges its sewage at Barking Creek. Casts of the renal tubules are truly the infallible evidence of renal destruction as to existence, if not as to extent. The character of the urine tells much; when it is copious and of low specific gravity, we have only too good reason to decide that the injury is extensive and widespread. Sometimes albumen is present in the urine,

* *The Lancet* report: Bright's disease not essentially a renal disease, but essentially and primarily a blood disease.

but its significance depends upon its associations. Dr. Richard Bright found that when albuminuria coexisted with dropsy the kidneys were the seat of disease. But in the diagnosis of several practitioners the dropsy factor drops out of the calculation, and the diagnosis is made in its absence. Albuminuria and "chronic Bright's disease" are, however, not convertible terms by any means, nor the equivalent of each other, as is not unfrequently assumed.

Chronic interstitial nephritis is but one of the numerous morbid progeny of the uric acid formation, albeit an important unit. We are all familiar with this vaso-renal change as it runs its course in the mesoblastic structures of the men of Norse type, large-boned, and florid, giving joint gout, cardio-vascular changes, chronic bronchitis, rheumatism, eczema, and secondary valvular disease in the large heart. That is one aspect of the vaso-renal change. But this is by no means the only aspect of this change. It may sometimes commence with primary kidney mischief, and consequent imperfect blood depuration. Far more frequently it starts from a congenitally "insufficient" liver. In persons of the neurosal diathesis or Arab type (to whom the term "neurotic" aptly applies), the phenomena are widely different.

The mesoblastic tissues are comparatively untouched, while the hypoblastic and epiblastic tissues are the seat of suffering. These persons are of spare habit, and complain of indigestion, acidity, and flatulence—matters of the hypoblast; of migraine, accompanied by vesical irritability, of palpitation, of failure of the heart's action, resembling syncope, except that they do not lose consciousness, and realize the horror of their condition—matters of the epiblast. In many cases cardio-vascular change is also present, and the migrainous neurotic is as liable to apoplexy as the red-faced, short necked, gouty man; the urine of the last is usually copious and clear, while in the neurotic the urine is often charged with lithates.

The migrainous neurotic of the uric acid formation is growing more and more common. Town populations have a tendency to grow smaller and darker, as any one can see by comparing the living crowd with the worthies in effigy at Madame Tussaud's. They have a tendency to revert to an earlier and lowlier ethnic form, and are smaller in the bone. They are precocious, and the early development of the nervous system is accompanied by a deficiency or backwardness in the assimilative organs. There is an insufficient liver, which really reverts to the uric acid formation; and this is aggravated by the fact that town dwellers eat more animal food than rustic populations of the wage class, while the latter have the advantage of plenty of oxygen. The town dweller works in ill-ventilated rooms, and his amusements are indoor in a vitiated atmosphere. With an insufficient liver, a meat dietary, and insufficient oxidation, the town dweller is the subject, more than all others, of the uric acid formation, with all its varied consequences. At Victoria Park Hospital I have under care at the present time a mite of a girl, not yet thirteen years of age, in whom all the phenomena of the migrainous neurotic are already present. The effect of town life is to produce a distinct retrogression to a smaller, darker, precocious race of less potentialities than the rustic population. Precocity is seen in early puberty, but reproduction is impaired; and Hayles Walshe, Mr. Cantlie, and others have shown that it is well nigh impossible to find a true Cockney of the fourth generation. Dr. Ralfe informs me that of eight hundred inquiries made at the London Hospital, only four resulted in genuine Cockneys of the fourth generation. The retrocedent race perishes either by sterility in the females, or their sparse progeny succumb to the diseases of childhood. These urban dwellers, the progeny of town-born parents, this retrocedent race, are the possessors of congenitally insufficient livers, and as a consequence are the victims of the uric acid formation. This liver reversion is the microcosm within the macrocosm. And Bright's disease is especially the disease of this urban race. Teetotalism and vegetarianism are no matters of mere caprice or fashion, but are the unconscious submission to an unseen law ruling the choice. The urban dwellers cannot tolerate the beef and ale of their rural forefathers. No doubt in many cases alcohol and syphilis play their part, and too often an important part. But these are only accessories to the great fact that the descendants of town dwellers die prematurely old of Bright's disease, and that the spring runs down at a much earlier period with them than with rural populations.

Many persons are remarking how common gout is becoming amid us at the present time. Such is certainly my personal experience; though articular gout is by no means the common outcome of the uric acid formation in town dwellers. Sufferers from articular gout are comparatively infrequent among the crowd of persons who are undergoing that vaso-renal change to which "chronic Bright's disease" is the term most commonly applied. In other cases neurotics are found with the uric acid formation, who seem to owe their "insufficient" liver to hard intellectual toil on the part of their fathers. Nearly every American lady of this class has given me a history of the long and usually successful efforts of her father. "The fathers have eaten sour grapes, and the children's teeth are set on edge." There seems some law of antagonism between the tissues of the epiblast and those of the hypoblast. Long sustained demand upon the brain as "the organ of mind" tells upon the viscera. The liver suffers therefrom; and the progeny of the hard-working brain toiler comes into this world with an insufficient liver. Clifford Allbutt, F.R.S., some years ago pointed out clearly the mental causes of Bright's disease, in an address which attracted much attention at the time and since. Not only does my experience fall in with his as to the individual, but it seems to teach a further lesson—viz., that hard, sustained brain toil has its Nemesis in an insufficient liver, which reverts to the uric acid formation. The bright, high-souled migrainous-neurotic, one of the most charming patients who enter the physician's consulting room, owes her fortune and her liver alike to her father's toil, which is rather a hard nut to crack for those whose ambition it is to make a fortune.*

Thus we see there are many factors—and some of them little suspected—at work in the genesis of Bright's disease. Nor is it inaccurate to say that it is a disease becoming daily more common in "this madly striving age." More familiarity with its causal relations ought to develop definite preventive measures.—*Lancet.*

* No wonder Bright's disease is so prevalent among the hard-working inhabitants of the United States of America.

A GIGANTIC TREE.

AT three leagues from the city of Oaxaca, the capital of the State of the same name, upon the road from Tlacolula, there is a small village called Santa Maria del Tule, of which the inhabitants are Miztec Indians. In the church cemetery of this village there is a gigantic tree, whose colossal proportions have attracted the attention of all those who have seen it, beginning with the learned Humboldt and ending with the humblest laborer.

The circumference of the trunk of this giant of another age, taken with all the circumvolutions of the bark, measures no less than 216½ feet. Its very bright green foliage proves how great the vigor of this tree still is, notwithstanding the thousands of years that have passed since its birth. The annexed engraving of the giant of Tule will allow its form and colossal dimensions to be appreciated.

The following is the nomenclature of the tree: *Taxodium mucronatum*, Ten.; Mexican cypress; Moctezuma cypress; Ahuehuete; Tarascan Ahuehuete.*

The tree grows in the valley of Mexico, in Oaxaca, Chiapas, Queretaro, and other regions of the Mexican republic.

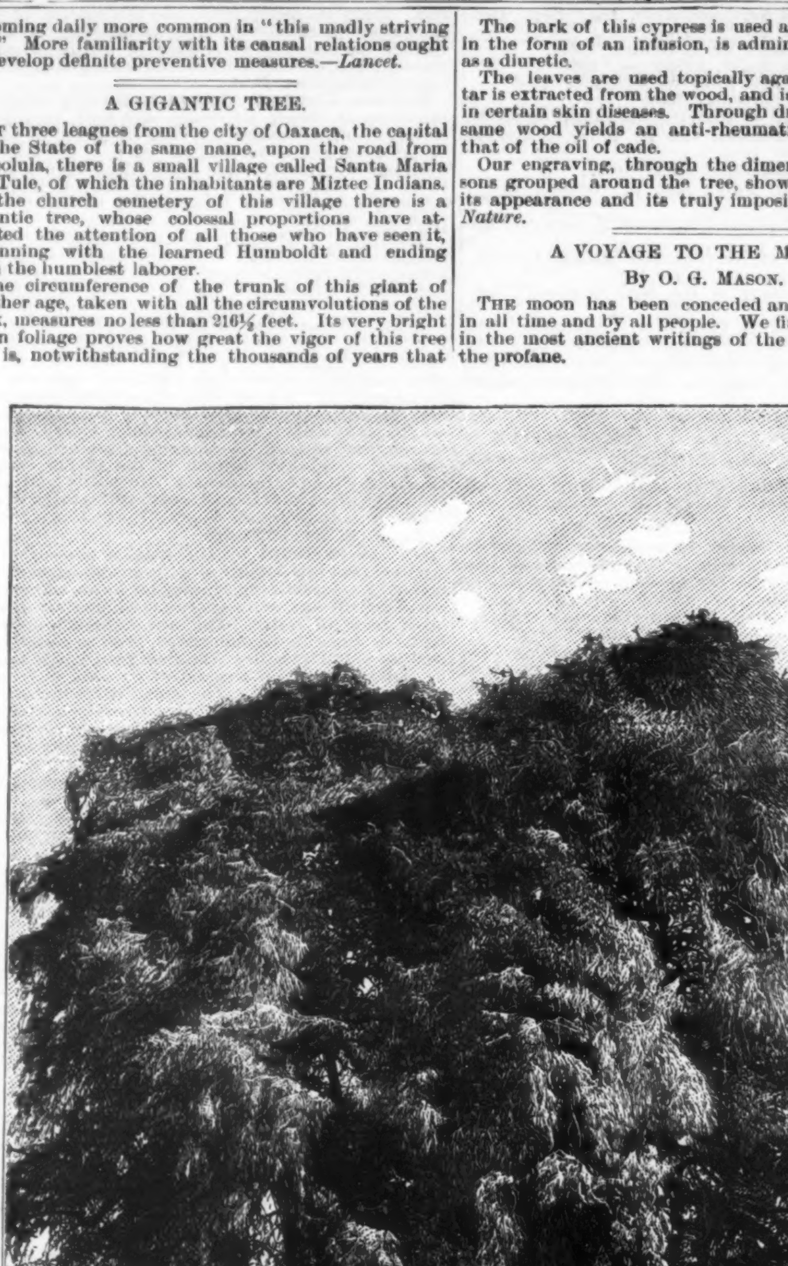
Through a simple distillation of the cones of this tree, Dr. Thomas Noriega, of Mexico, has extracted an essence of a greenish yellow color and an agreeable odor. This essence boils at 130°, and its density is 0·8259. Concentrated sulphuric acid colors it orange-yellow, which gradually takes on a rosy tint and finally passes to milk white. Iodine, when brought into contact with it, causes a slight explosion, with a disengagement of orange vapor. Dr. Noriega has likewise found in the same cones an unctuous resin of a dark red color. A solution of this resin in alcohol is of a red color, and in ether of a bright yellow. Although neutral, warm potassa partially dissolves it.

The bark of this cypress is used as a medicine, and, in the form of an infusion, is administered internally as a diuretic.

The leaves are used topically against the itch. A tar is extracted from the wood, and is successfully used in certain skin diseases. Through dry distillation, the same wood yields an anti-rheumatic oil, nearly like that of the oil of cade.

Our engraving, through the dimensions of the persons grouped around the tree, shows the majesty of its appearance and its truly imposing grandeur.—*La Nature.*

* From the Aztec name *Ahuehuetl.*



THE GIGANTIC CYPRESS OF TULE.

A VOYAGE TO THE MOON.*

By O. G. MASON.

THE moon has been conceded an object of interest in all time and by all people. We find it is mentioned in the most ancient writings of the ecclesiastical and the profane.

The rude and the barbarian have looked upon it with awe and wonder.

The civilized and enlightened have studied its ever changing phases with deeper interest than any other visible non-terrestrial object.

Very many mothers have taught their children that the man whose image they pointed out on its surface was an object of terror, whose bundle of sticks often came to the backs of disobediemt youth.

The savage and uncivilized have counted their seasons and the length of their lives by its lunations.

Lovers in many climes have whispered their joys and pledged their fealty by its reflected light, and counted the first circle of its changes after their union as the honeyed period of human existence.

To the astronomer, the moon has ever been an object of primary interest. It has been the first object to fix his attention when his newly adjusted telescope is used for actual observation. He may try its penetrating power upon some star group in the distance of unfathomable space, or seek a test for its definition upon

* Read before the Photographic Section of the American Institute.—*Anthony's Bulletin.*

the satellites of some great planet, or the separation of a star from its companion, but his first enthusiastic study is almost sure to be the surface of that luminary which has all his days been an unanswered question. The student of nature is not content with the opinions of others when equipped with a first class telescope; he wants the personal "I see" upon which to base his opinions regarding a subject upon which so many conflicting arguments have been advanced.

He has learned that the moon's distance from the earth has been accurately measured, that its mass has been calculated and its density determined. These are facts which have been mathematically demonstrated. He has been taught that "figures do not lie," but he is often a little skeptical regarding the truthfulness of all the theories of those who have made the figures. He wants to go over the ground himself; and that there really is ground for him to go over is the one fact for the demonstration of which some proof is now offered. When contemplating a long journey, we usually study certain conditions which it is expected may be met with. But in our present case, of whom shall we inquire? By one careful observer we are told that the temperature of the whole country we seek is far above that of any place on the earth; in fact, that millions of years of unclouded sunshine, where the days are 354½ hours long, has changed the whole surface to a field of glass—that all water and air have been burned out of existence. Another tells us that the surface is a vast field of ice, and that there is plenty of the rarest kind of air. That, instead of crawling along, as we do here on the earth, pressed down by a load of fifteen pounds to every square inch of our superficial measurement, we would there be so cheered and buoyed up by our surroundings, that the heaviest person in our party would weigh less than thirty pounds. Competent engineers tell us, after careful measurement, they find that our journey would be one of more than 238,000 miles, a distance for the traveling of which a fast express train requires about three hundred days.

One of our party suggested that we should go early in the evening, as the moon must then be much nearer than when far up in the zenith. But that is a mistake. When the moon is just above our horizon, the length of our journey would be about 4,000 miles greater than when she appears highest in the heavens.

The moon looks nearer when on our horizon, because we compare it with terrestrial objects in the field of vision. To dispel the illusion, look at the rising moon through a tube which will shut other objects from the view. A newspaper or large sheet of wrapping paper, rolled to a diameter of one or two inches, will serve for the experiment.

Apparent size is often far from the actual. As an illustration of this, most of us would say that the moon looks as large as the sun. But in reality it contains only [illegible] part as much matter; this apparent similarity of size resulting from the sun being four hundred times further from us.

One of the most curious and interesting relations of the earth and moon is found in the rotation of the moon around its own axis in the exact time required to swing in its orbit around the earth; consequently the same side is always toward the earth. And if the moon had no libration, we would never see more than one hemisphere of its surface; but as the moon has a swinging motion, similar to that of a slowly rotating top, some little distance beyond her north and south poles becomes visible. If the moon is inhabited, what a field there is for the enterprise of some lunar Cook, or other energetic excursion organizer, who would liberally advertise trips to see the earth! The length of the journey from the center of the opposite side of the moon would be less than the distance between New York and San Francisco. He could very truly call the show a big one, and those who purchased his tickets would—when they came in sight of this world of ours—see an object more than fourteen times larger than any they had ever before looked upon.

A lunarian's walk by full earth light must be a very brilliant affair in a light such as we would get from fourteen full moons.

But time is passing, and each one must make his or her own calculations regarding the inhabitants of our satellite.

At the northwest corner of Second avenue and 11th street, in this city, stands a large, plain, well-built brick dwelling, which has during many years been the city home of a man known and esteemed among the great minds of his age as a leader whom it is safe to follow; a man, the best years of whose life, and a large part of whose ample fortune, have been devoted to the advancement of astronomical science.

To the older members of the section, it will doubtless seem quite appropriate that we are thus reminded of the first president under whom our meetings were held, Lewis M. Rutherfurd.

To Mr. Rutherfurd is due the credit of organizing the plans by means of which the trip to the moon, partially described to-night, was made possible.

Upon an ample lawn in the rear of the house before alluded to was erected, in the year 1856, one of the best private astronomical observatories of the time. The building is of brick, and in the main consists of a circular observing room, twenty feet in internal diameter, with a projection on the westerly side for transit and computing rooms. The twenty-foot dome of the observing room rests upon twelve wheels, equally spaced in the iron coping of the brick wall. The lower edge, or base, of the dome is fitted with a band of cogs, which gear into a chain-belted wheel, actuated by a crank in the wall of the observing room. So admirably is this mechanism constructed, that the strength of a child is sufficient for setting it in motion.

On two opposite sides of the dome from base to apex are openings, two feet in width, which are closed by shutters easily worked from below, and so devised as to screen the room from wind when open.

In the center of the room, resting upon a firm foundation, deeply embedded in the fine sand underlying the whole building and grounds, stands the telescope pier, a broad, high block of stone, and around this, but not in contact with it, is laid the floor.

In the transit room, 189 feet northwest of Second avenue, and 76·3 feet northeast of 11th street, the transit pier was erected.

The principal instrumental furnishings of the establishment consist of a first-class equatorially mounted telescope of 13 inches aperture and 14 feet focal length; the readings of position are upon 18 and 20 inch silver circles.

The driving power is a Remontoir escapement clock of the highest merit. So accurate are its movements that the photographic image of faint stars, requiring long exposure, have a wonderful sharpness of outline.

The photographing of celestial bodies, attempted at various observatories previous to 1863, left much to be desired in definition. From some experiments made by Mr. Rutherfurd about that time, in connection with a government expedition, he was led to believe that a lens could be so constructed as to greatly improve astronomical photography, and, by a purely scientific method, he began his work of solving the problem.

By the use of the spectroscope he found that a lens of crown glass, so constructed as to shorten the focus of the observing telescope about $\frac{1}{10}$, gave promise of good results. Through the use of specially devised mechanism and methods of trial—the description of which would require too much time—he constructed with his own hands such a lens. Only those who have attempted to grind, polish, and correct a 13 inch lens can well understand the labor involved in such an undertaking.

When, on the night of March 6, 1865, this newly devised method was proved to be correct, by the production of the first really good photograph of the moon, it was at once expected that photography would occupy an important position in science, and add greatly to the advance of astronomical observation.

That such expectation has been and is now being realized no one questions.

Within the next few days will be held in Paris a congress of astronomers for the express purpose of apportioning the labor of making a photographic map of the entire heavens, and it is expected to complete the work within ten years, and that these plates will show a vast number of stars which no human eye has as yet seen, even with the aid of the most powerful instruments.

Certainly, we may be pardoned for expressing a little pride in the fact that all this was begun more than twenty years ago by a citizen of New York and a member of our section of the American Institute. From his observatory we started for the moon, or, rather, under its great revolving dome found means for pulling the moon down, to be hung on the wall for our inspection.

Our party consisted of three persons, whom we will designate as numbers one, two, and three.

At 10.30 P. M. number two entered one of the computing rooms across the lawn and called "time," by reporting the zenith clear and the air still favorable for first-class work, a coincidence averaging about twice a year in New York City.

Upon this announcement numbers one and three bundle up in heavy clothing as though about to visit the north pole. They know the weather is crisp and cold where the next few hours are to be passed.

As they enter the door leading to the dome, under which stands the great equatorial, the silence is broken only by the escapement wheel of the tall sidereal clock standing against the western wall, as its heavy pendulum swings to and fro with an accuracy most wonderful.

No other sound. Not a word is spoken; each knows his assigned duty, and to it he gives his undivided attention. All feel that such time is beyond value, and must be utilized to the fullest extent.

Number one has charge of the telescope. The dome is revolved into position, and a long, narrow section, from base to apex, swung open, leaving a strip of clear sky visible, in the center of which the moon glistens like a disk of burnished silver. The great instrument is swung into approximate position; the driving clock, constructed to run one hour, is wound; and while number one is busy making his final adjustments, we will watch number two, who has charge of the photographic department of the expedition. He has lifted a trap door in the floor near the stone pier, passed down a short ladder, and entered what may well be called a troglodyte's laboratory, lighted by one small wax candle, as care is necessary to keep the temperature low. After a few minutes the pupils of his eyes are expanded sufficiently to permit seeing the bottles, baths, and dishes required for his work. But we have no time to describe his chemicals or his method of using them.

Meanwhile number three, the timekeeper, has adjusted the chronograph (in whose record there will be no personal equation), placed his small, dim lights where they will illuminate the clock and the room just enough to see what is going on, and then taken his position, where he can hear distinctly the beat of the long pendulum, as its lower end, terminating in a hair-like wire, swings at each vibration through a glistening drop of mercury, closing the battery current uniting chronograph, clock, and shutter adjustment on the telescope.

All is now ready for action. Upon a signal being gived by number one, a sensitized plate is handed up from the cave, placed in its receptacle at the ocular end of the great instrument, just as it would be put into an ordinary camera.

The touch of an electric button, and away we go, or rather, we all keep very still.

The great clock says one, two, three, and the plate holder is opened to the light of the full moon, whose image the great glass eye, fourteen feet away, has condensed to a circle of $1\frac{3}{10}$ inches The buzz of the chronograph wheels is just audible as it records the time in hundredths of a second. The heavy pendulum has beat one, and the long focused eye is closed, the plate holder is returned to the troglodyte, who reaches from below to receive it, as he hands another up.

And so the work goes on until early morning, when the weary and thoroughly chilled party seek rest in a comfortable temperature and among surroundings which their animal natures deem far more enjoyable.

One of the old Hindoo systems of theology taught that the souls of men could leave their bodies for short periods of time in quest of knowledge, where no human body could ever go, and upon their return, by imparting to their fellow men the wisdom thus gained, an endless existence of perfect happiness was secured.

Thus wise must have been our trip to the moon. The mind or soul reached out with a question. Was it answered? Let us see if any knowledge gained can be imparted to others.

[Then followed the lantern exhibition of many slides, shadowing the moon's surface; its mountains, more than twenty thousand feet high; its craters, fifteen and eighteen thousand feet deep, and from one to three hundred miles in diameter, were graphically described, and an explanation of the various theories advanced regarding the existence of air and water on the moon's surface; and some of the arguments used in support of such theories were examined. Dr. Mason closed his paper and description of the work done at the observatory by expressing regret that the telescope had been recently placed in the observatory of Columbia College, where he feared vibration would prevent its use for fine photographic work.]

THE ACTION OF FERRIC SULPHATE ON IRON.

By ALBERT E. MENKE.

THE deleterious action of ferric sulphate on boilers has been the cause of much trouble to engineers, owing to the fact that it appears to cause rapid corrosion. Experiments have been made to determine the action of ferric sulphate in solutions of different strengths on different irons, and to see how far it is possible to stop the destructive effects. In the first series of experiments pure iron wire was taken, a certain amount of water and ferric sulphate added, and the whole then heated in flasks with reversed coolers. For purposes of comparison, blank experiments were made with iron and water, leaving out the ferric sulphate. The following results were obtained:

No. of Expt.	Actual Loss.	Calculated on Blank.	Rust Formed.	Amount $Fe(SO_4)_3$ Used.	Weight Fe Taken.
1	·0135	·0133	·0002	·0016	1·1515
2	·0115	·0111	·0004	·0032	·9590
3	·0130	·0112	·0018	·0048	·6660
4	·0193	·0128	·0065	·0064	1·0965
5	·0161	·0108	·0053	·0080	·9814
6	·0214	·0135	·0076	·0096	1·1720
7	·0198	·0122	·0076	·0144	1·0507
8	·0040	·0032	·0008	·0016	·2816
9	·0080	·0033	·0047	·0032	·2805
10	·0050	·0036	·0014	·0048	·3130
11	·0030	·0028	·0002	·0064	·2440
12	·0035	·0026	·0009	·0080	·2295
13	·0036	·0028	·0008	·0096	·2464
14	·0070	·0032	·0038	·0144	·2800
15	·0030	·0030	·0030	None.	·2584
16	·0029	·0029	·0029	None.	·2576

The results in Column 3 were obtained by calculation from Experiments 15 and 16. All were heated the same length of time—fifteen hours. It will be noticed that there is a slight increase of oxidation as the strength of the ferric sulphate increases. The next set of experiments was made with the substances inclosed in sealed tubes and heated to 110° C. for fifteen hours.

No. of Expt.	Amount Rust Formed.	$Fe_2(SO_4)_3$ Used.	Weight Iron Taken.
17	·0005	·0016	·6930
18	·0006	·0016	·7390
19	·0008	·0032	·7860
20	·0005	·0032	·7 30
21	·0010	·0048	·8350
22	·0015	·0048	·7700
23	·0002	None.	·7900

It will be noticed here, again, that the rust increases with the ferric sulphate. In the next set of experiments, Nos. 24 and 25 had nothing but the iron and ferric sulphate solution, Nos. 26 and 27 had the calculated amount of sodic carbonate, Nos. 28 and 29 the potassic carbonate, and Nos. 30 and 31 the calcic carbonate requisite for decomposing the ferric sulphate. These experiments were made in sealed tubes heated to 110° C. for fifteen hours. The results are interesting, and show that the alkaline carbonates have a good effect in stopping the formation of rust.

No of Expt.	Amount Rust Formed.	$Fe_2(SO_4)_3$ Used.	Weight Iron Taken.
24	·0025	·0093	·9596
25	·0028	·0093	·9331
26	·0010	·0093	·9818
27	·0011	·0093	·9166
28	·0010	·0093	·9504
29	·0006	·0093	·9431
30	·0023	·0093	1·0178
31	·0024	·0093	·9666

In the next set of experiments the temperature was raised to 160° C., the tubes being heated, however, only three hours.

No. of Expt.	Rust Formed.	$Fe_2(SO_4)_3$ Used.	Weight Iron Taken.
32	·0012	0934	·8898
33	·0004	0934	·9192
34	·0006	·0934	·9564
35	·0005	·0934	·9840

The action here has been more rapid as the temperature and pressure increased. The next series of experiments was made with boiler iron of good quality. The pieces of iron used were about one half inch long, one-eighth inch thick, and one-eighth inch wide. The action was not as vigorous as in the experiments with pure iron.

No. of Expt.	Rust Formed.	$Fe_2(SO_4)_3$ Used.	Weight Iron Taken.	Remarks.
36	·0101	·0934	7·2561	Alone.
37	·0089	·0934	8·6119	Alone.
38	·0045	·0934	9·1265	$+NaHCO_3$
39	·0035	·0934	8·8775	$+NaHCO_3$
40	·0040	·0934	9·6142	$+K_2CO_3$
4:	·0030	·0934	7·9619	$+K_2CO_3$
42	·0046	·0934	8·9392	$+CaCO_3$
43	·0046	·0934	7·5256	$+CaCO_3$

The above experiments were conducted in sealed tubes heated to 110° C. for 15 hours.

The next set of experiments was made in sealed tubes heated to 160° C. for 3 hours.

No. of Expt.	Amount Rust Formed.	$Fe_2(SO_4)_3$ Used.	Weight Iron Taken.	Remarks.
44	·0124	·0934	8·2238	Alone.
45	·0052	·0934	6·5678	$+NaHCO_3$
46	·0048	·0934	6·5075	$+K_2CO_3$
47	·0076	·0934	. 7·3948	$+CaCO_3$

The action here, as when pure iron was used, has been more rapid. This was proved to be the case by

making two experiments and testing the amount of rust formed every hour for ten hours successively. In the tube heated to 110° the action was gradual; in the tube heated to 160° most of the rust was formed in the first hour. How long the action goes on, and at what rate it progresses, has not yet been determined. The next set of experiments was made with small pieces of steel, and here the action was the slowest.

No. of Expt.	Rust Formed.	Amount $Fe_2(SO_4)_3$ Used.	Weight of Steel Taken.	Remarks.
48	·0064	·0934	7·7526	Alone.
49	·0062	·0934	7·6843	Alone.
50	·0020	·0934	7·4232	$+K_2CO_3$
51	·0025	·0934	7·3965	$+K_2CO_3$
52	·0031	·0934	7·5742	$+NaHCO_3$
53	·0028	·0934	7·4962	$+NaHCO^3$
54	·0048	·0934	7·7923	$+CaCO_3$
55	·0042	·0934	7 7800	$+CaCO_3$

The above were heated to 110° C. in sealed tubes.
The following were heated to 160° C. in sealed tubes:

No. of Expt.	Rust Formed.	Amount $Fe_2(SO_4)_3$ Used.	Weight of Steel Taken.	Remarks.
56	·0072	·0934	7·8423	Alone.
57	·0030	·0934	7·6364	$+NaHCO_3$
58	·0026	·0934	7·7982	$+K_2CO_3$
59	·0041	·0934	7 6541	$+CaCO_3$

Potassium carbonate all through seems to be the best preventive, but its expense will, in most instances, preclude its use. Sodic carbonate was tried in all kinds of proportion, but in no case was there complete arrest of the oxidation. The best amount of sodic carbonate to use is 1⅛ grains for every grain of ferric sulphate found in the water. Further experiments in the retarding of rust formation are now in progress.

Kentucky State College.

—*Amer. Chem. Jour.*

SPECIFIC GRAVITY OF LIME WATER.

I have recently had occasion to take the specific gravity of lime water, and have noted a peculiarity which appears to me to be of very great interest. According to a recent determination in my laboratory, a liter of lime water contains 1·344 grms. of CaO, and the specific gravity of the lime water reaches the extraordinary figure 1·02 35, compared with distilled water at the same temperature reckoned as 1000·00 (the temperature was 13° C.)

It follows from these observations that in the formation of lime water a most extraordinary contraction takes place.

Before solution:

CaO............	0 5 c.c.=	1·344 grms.	
H_2O............	1001·0	" =1001·0	"

which contract so as to occupy one liter.

The contraction is, therefore, three times the volume of the lime which dissolves in the water and forms lime water.

The purity of the lime water was ascertained by exactly precipitating the lime by means of its equivalent of oxalic acid, filtering, and evaporating the filtrate to dryness; the residue was so small as to be insignificant.—*J. Alfred Wanklyn, Chem. News.*

ACTION OF ZINC CHLORIDE ON CASTOR OIL.

At a recent meeting of the Society of Chemical Industry, a paper by Dr. C. R Alder Wright, F.R.S., was read on "The Action of Zinc Chloride upon Castor Oil," setting forth that the radical in castor oil is different from that of several other oily acids, in that it contains more oxygen. The glyceride of ricinoleic acid differs in various chemical and physical characters from the glycerides of the other common oils. The author and Dr. Muirhead found that zinc chloride in strong solution, or in the form of fused hydrated crystals, has a marked power of thickening and solidifying castor oil into a gristly mass, suitable for mixing with artificial colloidal insulating substances for electrical purposes, and that the kind of product can be regulated by varying the temperature and proportions of the mixture. The most effective treatment consists in evaporating down a solution of zinc chloride until its boiling point rises to nearly 175° C.; it is then allowed to cool to about 125° C., and is well intermixed by agitation with one third its weight of castor oil at about the same temperature. The oil is rapidly converted into a thick clot, and separates from the zinc chloride in lumps; it becomes a mass of cartilaginous nearly white shreds when deposited in water and agitated therewith. The zinc chloride is practically all recovered, and can be used over again. The shreds are practically insoluble in the various menstrua which dissolve castor oil; but the glyceridic character is not destroyed.

INOSITE.*

This substance was first obtained by Scherer from muscular tissue, and has since been found to be a constituent of a large number of plants. The difficulty of obtaining it in any quantity has hitherto prevented its exact study. M. Maquenne has succeeded in obtaining a considerable quantity of it by extracting dried leaves of the walnut tree with water, and has subjected it to careful investigation. He finds that it has the composition represented by the formula $C_6H_{12}O_6+2H_2O$; and a determination of its molecular weight by the cryoscopic method of Raoult is also found to be in accord with this formula. It is optically inactive, and suffers no change when left in contact with *Penicillium glaucum.* Its molecule, hence, cannot contain an asymmetric carbon atom according to the rule of Le Bel and Van't Hoff. Inosite is not attacked by acids or dilute alkalies. It does not reduce Fehling's solution, nor does it act upon an ammoniacal silver solution. With acid sodium sulphite it does not unite, nor is it reduced by sodium amalgam. The halogens do not act upon it in the cold, but when it is heated with bromine to 100° C. it yields oxidation products similar to those obtained with nitric acid. Inosite is not an aldehyde nor an acetone, since it does not give, on oxidation, an acid containing six atoms of carbon, nor oxy-acids of the fatty series. Its molecule then cannot contain a lateral chain, and it must therefore be a hexatomic alcohol derived from hexahydro-benzene—*i. e.*, hexahydrohexoxy-benzene, $C_6H_6(OH)_6$. The symmetry of this formula excludes, according to the theory of Le Bel and Van't Hoff, all rotary power. In another paper,* Maquenne shows that, by reduction with hydriodic acid, anhydrous inosite yields a small quantity of benzene and tri-iodophenol—a fact which lends strong support to the formula proposed by him. On oxidizing inosite with concentrated nitric acid, he obtained oxy-quinones, such as tetraoxy-quinone, rhodizonic acid, triquinone and croconic acid, all of which have been previously obtained by Nietzki and Benckiser from hexoxy-benzene, $C_6(OH)_6$. Hence inosite has the structure represented by the hexagonal symmetrical formula above given, since it yields, both on oxidation and reduction, derivatives of benzene.—*W. R. O., Amer. Chem. Jour.*

* *Comptes Rendus*, 104, 4, 225.

* *Comptes Rendus*, 104, 5, 297.

CARMINE SOLUTION.

Mr. Joseph W. England, in a paper read before the Pennsylvania Pharmaceutical Association on "Carmine as a Coloring Agent," gives the following formula for carmine solution:

Carmine (No. 40)................	4 drachms.
Water of ammonia	3 ounces.
Glycerin........................	3 ounces.
Water sufficient to make..........	8 ounces.

Rub the carmine into a fine powder in a Wedgwood mortar, make a paste with and dissolve in the water of ammonia, and then add, with constant trituration, the glycerin. Transfer to a porcelain capsule, and heat upon a water bath until the liquid is entirely destitute of ammoniacal odor, cool, and add the water. The entire removal of the ammonia gas requires the constant stirring of the liquid with a glass rod and rather lengthy heating.

The finished product is a permanent, deep ruby red liquid. It should develop no precipitate with mercuric chloride, indicating the absence of free ammonia gas, and on the addition of ammonium hydrate should acquire a purplish tinge.

This solution gives the true carmine color to solutions without exhibiting the purplish tinge so characteristic of alkaline solutions.—*Druggists' Circular.*

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